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CONTENTS.

| | PAGE. |
|---|---|
| Manuring | 253 |
| Industrial Chemistry makes many uses of Cellulose as a Raw Material in a wide range of Manufactures | 255 |
| Genetic Behaviour of a Mutant in a Trinidad Cotton Stainer (*Dysdercus urichi*) | 256 |
| Recent investigations on sugar-cane and sugar-cane soils in St. Kitts. II | 257 |
| Vernalization | 265 |
| Crop Products Manufacture in 1935 | 266 |
| Studies in West Indian Soils | 268 |
| West Indian Notes | 274 |
| Reviews | 277 |
| Sugar Notes | 278 |
| Chemical Notes | 279 |
| Trend of the Markets | 280 |

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*TROPICAL AGRICULTURE is published monthly at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad, West Indies. Advertisement and subscription rates can be obtained at the College from the Editor, or from the Secretary of the College, 14, Trinity Square, London, E.C.3, England. The Editor will be glad to consider authoritative articles for publication. It is understood that opinions expressed or recommendations made in signed articles or in articles of which the source is named are those of the author and do not necessarily represent the policy or opinion of the College Authorities. Increasing numbers of inquiries are being received from the various parts of the tropics which can be answered only by persons possessed of an intimate knowledge of local conditions. Enquirers should first satisfy themselves that their local Department of Agriculture is not able to supply them with the desired information before communicating with us. Correspondence which will be replied to is invited on all other matters pertaining to tropical agriculture, science and development.*

## MANURING.

FROM time to time accounts are given in the pages of this Journal of experiments on manurial treatment of various tropical crops, and it is felt that it would be apposite at the present juncture to examine the main implications behind the results obtained, since there is definite and increasing evidence that traditional beliefs on the subject in certain cases require to be qualified and emended.

Long before the rôles of Nitrogen, Phosphate and Potash in plant economy had been elucidated, it was accepted as axiomatic that plants grew more luxuriantly where organic matter had been incorporated in the soil. In most countries, farmers and planters generally still regard farmyard or pen manure as the most satisfactory all-round dressing to give to the majority of their crops. The effect of organic manure on soil is actually extremely complex. Broadly, it may be divided into two main components: (1) the physical effect of the colloidal system of decomposed vegetable débris on the structure and texture of the soil, and (2) the chemical effect of the interchanges which accompany decomposition. The repercussions of the simultaneous operation of these factors on the flora and fauna of the soil provide a wealth of biotic phenomena as yet almost uninvestigated. Nothing is known in detail, for instance, about the sequence of faunal associations in soil throughout the period of decomposition of a particle of organic manure, or how desiccation or waterlogging affect the relative components of such associations, whether any climatic factor extends the period of dominance of one group, or completely 'telescopes' a stage of the biological sequence, and whether this is of importance to the plant. The whole problem may ultimately prove to be not so academic in its interest as it may appear at present. Already knowledge is increasing concerning the mycorrhizal association of plant roots, in which the thriftiness of the higher plant depends directly on the activities of the fungus situated in the outer cells of its finer rootlets. The manurial requirements of a tree depending in this way on a fungal symbiont are probably intimately related with the physical environment in the soil, and the response of the tree to an application of manure may be the result of a very complicated series of metabolic processes on the part of quite different, but associated, organisms. If it could be assumed that the intermediate processes were in all cases quite unvarying and automatic in their action, and that application

of mineral manures would inevitably be followed by a proportionate and quantitatively predictable response in the plant, then the intermediate stages of the integration might be ignored. As it is, however, it is doubtful whether such an assumption is possible; the results of manurial trials very frequently show significant interactions between 'seasons and treatments', &c. and it must be admitted that at present little is clearly understood regarding the precise manner in which seasonal conditions exert their effects on yield, especially in the absence of periods of extreme dryness or humidity. While it is very probable that the effects of seasonal variation in aerial conditions have little or no direct influence on the soil below a depth of a foot or two, the influence which they may exercise indirectly on the soil environment immediately around the rootlet surfaces (where exchange of solutes is in progress) may be considerable, and it is this particular area of soil, changing as the root-tips grow, which is of most importance to the plant. It is here that nutrient substances in solution are taken into the sap, and the supply at the surface of the root hairs is maintained by a mechanism of seepage and diffusion from more remote regions in the soil.

With advances in the manufacture of chemicals on a large scale, considerable attention has come to be paid to the chemical aspects of manure. It was soon found that the principal mineral constituents of plants consisted of the three now universally recognised as N, P and K, and accordingly various inorganic compounds containing them separately were made available at relatively low prices. There is now abundant evidence that these chemicals do frequently produce responses of varying intensity in the plant. This has led certain groups of manufacturers to carry the combination of "balanced" manures to a point where formulae for the three constitutents are quoted in fractions, as well as integers. Such slight percentage differences in composition are almost certainly not appreciable when the manures are applied in the field over wide areas, in which the relatively simple sequence of "cause and effect" of the laboratory sand-culture is not reproduced.

This point leads to a topic now commanding increasing attention: it has long been known that manuring generally has a favourable influence on yield. At the same time, it is known that in certain circumstances indiscriminate manuring can have no beneficial effect at all. The causes of this effect are complex. If it be assumed that the plant requires a certain balance in its soil nutrients, it is clear that before the balance can be adjusted by the application of mineral manures the original status of the mineral content of the soil must be known at least to some extent. In most cases it is not, with the result that occasionally the proportions of the added material do little or nothing to correct the defective balance. A rather more striking fact which will no doubt be carefully considered in future work is that the presence of certain abnormal mineral substances in the soil may depress the uptake of components of the fertilizer. In Trinidad, for example, gypseous soils are very recalcitrant to improvement by the addition of phosphate, though the nutrient status is well understood and the manurial substance for addition is selected accordingly. Further research will probably bring to light other mineral associations which have a depressing effect on the uptake of certain ions necessary for balanced nutrition.

The question of the effects of rare elements calls for further detailed study by agricultural workers. It is not very likely that spectacular results will be achieved purely on account of their inclusion in manurial treatments. They are the necessary antidotes to certain deficiency diseases, and their presence probably would merely serve to prevent the occurrence of such disease, rather than produce a quantitative effect on yield corresponding to application. Not until the effects of such substances have been investigated, however, will it be possible to state with assurance whether a particular soil should receive a dose of a particular rare element to meet the requirements of a given crop.

The planter who wishes to increase the yield of his crop is faced with the problem of what fertilizer he should apply, and how much it should cost. The course usually followed, in the cases where manuring is carried out, is to purchase a ready-mixed fertilizer and apply it at the rate recommended by the manufacturers. If beneficial results are achieved the procedure is repeated. There is no simple way by which the planter himself can ascertain whether the manure as a whole is producing the satisfactory results, or whether certain of its components singly or together are responsible. The solution can be sought by manurial trials, but relatively few planters are sufficiently well equipped to undertake work of this type.

Rather more important is the question of achieving a balanced nutrient status in the soil. Haphazard manurial treatment must often mean unnecessary expenditure, and it is important that the planter should be in possession of at least a few facts about the chemical composition of the soil he intends to treat before he makes his decisions. His difficulty lies in the fact that, at present, the obtaining of such information is not a matter of simple enquiry and answer. Many agricultural centres have a system whereby for a small fee a planter or farmer can submit samples of the particular soil in which he is interested, collected according to definite directions, and duly receive an analysis giving the general status of the soil with regard to certain nutrients. It clearly does not follow that definite manurial recommendations can be given, since, though a soil may be proved deficient in one available element, the addition of the lacking nutrient may possibly be of little value owing to a depressing action exerted by the presence of some undesirable component. Apart from reservations of this type, however, it would be reasonable for a planter to decide to apply a particular element to a soil in which it had been proved to be present only in relatively very small amounts.

In some countries attempts have been made to supply planters with field kits, consisting of a few simple but effective reagents, with which they may seek information regarding the nutrient content of their soils. Accurate chemical analysis, however, calls for special apparatus and technique which can be carried out only in a laboratory. At the moment therefore, the progressive planter is often in somewhat of a dilemma as regards application of manure, since there may be no definite system established on a commercial basis for routine analysis of small soil samples in his area. As the use of fertilizers becomes more widely adopted (as it inevitably will be), an increasing need will arise for local soil bureaux to which planters can refer for prompt information regarding their own particular soils.

## INDUSTRIAL CHEMISTRY MAKES MANY USES OF CELLULOSE AS A RAW MATERIAL IN A WIDE RANGE OF MANUFACTURES.*

For chemical purposes, cellulose from wood and the cotton plant is used almost exclusively. The cellulose in wood is isolated by digesting wood chips under pressure with sulphite liquor (made from lime and sulphur), although for paper other processes such as the soda and sulphite methods are used to free the cellulose from the other constituents of the wood. Cellulose in the form of cotton or cotton linters is found in a much higher state of purity in nature and therefore requires less drastic treatments in its preparation for chemical use. Crude cotton linters are purified by digestion in dilute caustic soda solution under pressure at elevated temperature. High quality cellulose can be produced from many other cellulosic materials such as sugar-cane bagasse, corn-stalks, bamboo flax, hemp, but to date these sources of cellulose have not been able to compete economically with wood. When cellulose is treated with a mixture of nitric and sulphuric acids, a cellulose derivative known as nitrocellulose is formed.

Nitrocellulose dissolves in many solvents such as ether-alcohol, ethyl acetate, butyl acetate, to give viscous solutions or "dopes". If these solutions are spread in thin layers on a smooth surface and the solvent allowed to evaporate, a transparent flexible film remains. This characteristic of nitrocellulose, as well as of other derivatives of cellulose, constitutes one of the fundamental bases for the broad application of cellulose and cellulose products. This property, as can readily be seen, forms the basis for the manufacture of film for motion pictures, X-ray, and photographic purposes, lacquers and finishes, cements, coating compositions for cloth, book cloth and other coated textiles, for all of which uses the formation of a tough flexible film is required. In most cases modifying agents such as softeners and plasticizers are blended with the nitrocellulose in order to produce films of different characteristics as regards flexibility, softness, rigidity, suppleness, and many other characteristics. In the case of lacquers and coating compositions, colour effects are obtained through the incorporation of dyes and pigments.

### Cellulose in Plastics.

Another fundamental characteristic of nitrocellulose and certain other cellulose derivatives is their property of becoming plastic when blended with various compounds known as plasticizers. One of the most common plasticizers is camphor which is used with nitrocellulose in the manufacture of "Pyralin" plastic. As the reader well knows, beautiful effects are obtained in such plastics through the various blending processes involving the use of dyes and pigments. These effects are exemplified in toilet articles, fountain pens, umbrella handles and many other articles. Transparent "Pyralin" sheeting forms the protecting interlayer in laminated safety glass. Space is too short for describing the numerous other uses for this plastic. It may be said that this material finds its way into all households in important large or small uses essential to the comforts and conveniences of every-day life.

### How "Cellophane" is Made.

When cellulose is treated with a solution of caustic soda and carbon disulphide (a liquid made from coal and sulphur), a cellulose derivative known as cellulose xanthate is formed. This cellulose derivative, when dissolved in dilute aqueous caustic solution, forms a viscous solution known as viscose. When viscose is treated with an aqueous solution containing a salt and an acid, the cellulose xanthate is coagulated and the cellulose is regenerated. If viscose is extruded in sheet form into such a solution, the cellulose is regenerated in the form of a film. Such a process forms the basis for the method used for manufacture of "Cellophane" (du Pont's trade-mark for its cellulose film). Of course, the regenerated cellulose sheet is subjected to many subsequent steps before the finished product is obtained. For example, the crude sheet is washed to remove salts and by-products and then glycerin is introduced to maintain a soft pliable sheet after the product is dried. In making moisture-proof cellulose films, the sheeting is subjected to a coating process.

### Rayon a Cellulose Product.

If viscose is squirted through small holes, known as spinnerets, into an acidic solution, the cellulose is regenerated as a fine filament, many of which are combined to form viscose rayon yarn. In the commercial production of rayon, the viscose is spun simultaneously from numerous spinnerets, each of which contains numerous holes. During the spinning process it is important that speed of travel and the degree of stretching of the filaments be controlled carefully to produce a rayon of the highest quality. Attention must be given also to the minutest details in the washing, bleaching, and drying of the product.

* Extracted from *Agric. News Letter*, Vol. IV, No. 8, 1936. Issued by E. I. du Pont de Nemours & Co., U.S.A.

# GENETIC BEHAVIOUR OF A MUTANT IN A TRINIDAD COTTON STAINER (*DYSDERCUS URICHI*).

By S. C. Harland.

In February 1930, Mr. E. O. Pearson collected adults of *Dysdercus urichi* China, sp. nov., feeding on Asiatic cotton at the Trinidad Cotton Research Station. These when bred gave a batch of normal red adults. In April 1930, a mixed second generation from this batch produced four nymphs, which instead of being the normal red colour were white. One white male was ultimately raised to maturity; the other three individuals remained an abnormally long period in the fifth instar and had difficulty in shedding their exuviae. When adult the white individuals were red, and indistinguishable from the normal red type.

The white male was mated with three sister normal reds and gave results as follows :—

| *Family.* | *Red.* | *White.* | *Remarks.* |
|---|---|---|---|
| 1 | 24 | 16 | |
| 2 | 13 | 9 | Some whites pinkish. |
| 3 | 23 | 0 | |

These results though meagre are not inconsistent with the hypothesis that "white" is due to a recessive mutant in the original red stock. White mated to homozygous red should give all red; this is the case in Family 3, and mated to heterozygous red should give equal numbers of red and white. A further series of experiments were undertaken to confirm this provisional hypothesis. An account of the data obtained follows :—

1. White × white gave all white.
2. White × unrelated red taken from *Malachra*.

$F_1$.

After being mated five days, 46 eggs were obtained, and red eyes could be seen distinctly in three days. Of three batches of eggs only seven stainers reached maturity, six females and one male. These were all red like the male parent.

$F_2$.

The $F_1$ male was mated with one of its sisters, and in four batches of eggs 24 nymphs hatched of which 18 were red and six white.

B.C.

Using three $F_1$ females, mating them with a white male and numbering them A, B, C, the following results were obtained, on examination of the first instar :—

| *Family.* | *Red.* | *White.* |
|---|---|---|
| A .... .... .... | 80 | 71 |
| B .... .... .... | 12 | 16 |
| C .... .... .... | 2 | 0 |
| Total .... | 94 | 87 |
| Expected .... | 90.5 | 90.5 |

The expected 1 : 1 ratio is closely realized.

The reds of the backcross when intercrossed gave the following results :—

| *Family.* | *Red.* | *White.* |
|---|---|---|
| A1. .... .... .... | 11 | 3 |
| A2. .... .... .... | 32 | 19 |
| A4. .... .... .... | 38 | 9 |
| A5. .... .... .... | 36 | 4 |
| Total .... .... | 117 | 35 |
| Expected .... .... | 114 | 38 |

This ratio is near to the 3 : 1 expected.

The backcross whites when inbred produced three families giving 15, 17, and 10 whites respectively.

To sum up: the mutant of *Dysdercus urichi* which is white in the nymphal stage behaves as a simple recessive to the wild type.

*Pink forms in second and third instars.*

The clear segregation into 1 : 1 and 3 : 1 ratios was exhibited very clearly in the first instar, and even in the eggs before they hatched, since the eye-colour was visible through the egg shell when a few days old. It was noticed that a number of pink forms appeared in the second and third instars rendering classification into red and white difficult. This may be considered as due to the presence of minor modifying factors which manifest themselves in a similar way to the main colour producing gene, though to a lesser degree.

A similar case has been recorded in cotton by the writer (1929) where minor genes for petal spot can cause a faint development of spot when the main spot gene is absent.

## Summary.

A white nymphal mutant of a species of Cotton Stainer, *Dysdercus urichi*, native to Trinidad, proved on breeding tests to be a simple recessive to the normal form.

## Acknowledgments.

I am indebted to Mr. E. O. Pearson, now of the Empire Cotton Growing Corporation's Station at Barberton, South Africa, for the original Stainers used in these experiments, to Mr. W. E. China of the British Museum, who kindly identified the species as *Dysdercus urichi* sp. nov., and to Miss Olga Atteck who carried out the experimental work.

## Literature.

Harland, S. C., 1929.—The Genetics of Cotton, Part I. The Inheritance of Petal Spot in New World Cottons. *Jour. Genetics* 20: 365-385.

# RECENT INVESTIGATIONS ON SUGAR-CANE AND SUGAR-CANE SOILS IN ST. KITTS.

## II.—EXPERIMENTS WITH VARIETIES, WITH TIME OF PLANTING, AND WITH DISTANCE OF SPACING, REAPED IN 1936.

By. P. E. Turner and R. E. Kelsick.

### Introduction.

A Scheme of field experiments was inaugurated in St. Kitts in 1933 under the auspices of the Sugar-Cane Investigation Committee of the island. The design of the scheme is such as to make thorough and systematic inquiry into the more fundamental practices in use on the sugar estates of St. Kitts and to compare their merits with alternative practices which have proved successful in other sugar-growing countries, due regard being paid to local conditions.

Detailed descriptions of the scheme have been published elsewhere (1). As the scheme develops it is intended to include experiments grouped under the following headings :—

*Cultural.*
Preparation of the Soil for Planting.
Cultural Treatment after Planting.
Cultural Treatment of Ratoon Canes.

*Conservation of Soil Moisture.*
Mulching with Megasse, Trash, &c.

*Varieties.*
Comparison of Varieties.
Time of Planting.
Distance of Spacing.

*Liming.*
Use of Lime on Acid Soils.

*Manuring.*
Manurial Treatment of Plant and Ratoon Canes on Penmanured and Unpenmanured Soils.

For the purpose of the experimental scheme the sugar-cane areas of St. Kitts are classified into natural groups which are determined by their position on the glacis and on rainfall (2).

(1) *Lower Lands*, which form the coastal belt at the foot of the glacis, and which are customarily penmanured at each replanting.

Two rainfall zones may be distinguished within the lower lands :—

(*a*) a zone of low rainfall, where lack of moisture* is the main factor limiting yield, and to which the variety B.H.10(12) is not suited ;

(*b*) a zone of good rainfall as a rule, to which B.H. 10(12) is suited, but which on occasion is subject to severe drought.

(2) *Upper Lands*, which are bordered on the lower side by the coastal belt and on the upper side by forest. The upper lands in general are not penmanured.

Rainfall is ample and well distributed on the upper lands, except in the case of certain isolated areas. B.H. 10(12) is the variety preponderantly grown.

A preliminary series of experiments laid down under the experimental scheme was harvested in 1935. The information to which these experiments gave rise has been summarised in earlier issues of this *Journal* (2).

A second series of experiments has been reaped in 1936. In this paper an account is given of the results obtained from the 1936 experiments with varieties, with time of planting and with distance of spacing. The second series of cultural, mulching, liming and manurial experiments will be discussed in a future paper.

### Variety Trials on Plant Canes and Ratoons.

The yield data for the plant canes set out in Tables I, II and IV have been previously fully discussed (2).

The Dry Areas of the Lower Lands.

The variety S.C. 12/4 is largely grown in the dry areas. The data recorded in Table I enable a comparison of the yield of cane and of sugar given by plant and ratoon canes of this variety and the variety B. 2935.

**Table I.—A comparison of the standard variety S.C. 12/4 with B. 2935.**

*Estate* : Camp. *Soil* : Sandy loam.
*Planted* : 7/11/33.
*Reaped* : 12/2/35 as plants ; 5/2/36 as first ratoons.
*Rainfall* : 66 inches as plants (15¼ months).
34 inches as first ratoons (11¾ months).
*Layout* : Six randomised blocks with both varieties repeated twice in each block.

| Variety. | Cane (tons per acre). | | | Sugar (tons per acre). | | |
|---|---|---|---|---|---|---|
| | Plants 1933-35 | 1st R. 1935-36 | Total 1933-36 | Plants 1933-35 | 1st R. 1935-36 | Total 1933-36 |
| B.2935 .. | 47.38 | 24.95 | 72.33 | 4.44 | 2.59 | 7.03 |
| S.C. 12/4 .. | 36.06 | 22.50 | 58.56 | 3.47 | 2.16 | 5.63 |
| Difference .. | 11.32 | 2.45 | 13.77 | 0.97 | 0.43 | 1.40 |

* Due account should be taken of the lightness of texture and high degree of porosity of the soils of St. Kitts in relation to amount of rainfall (2).

The experimental area was dressed with 25 tons of pen manure and 3 cwts. of sulphate of ammonia to the acre as plant canes and 3 cwts. of sulphate of ammonia to the acre as ratoons. Both the plant canes and the first ratoons were reaped very early in the dry season.

*Plant Canes* (2).

The plants of B. 2935 gave to the acre 11.32 tons of cane and 0.97 ton of sugar more than S.C. 12/4.

*First Ratoons.*

The rainfall at Camp Estate during the early life of the ratoon canes in 1935 was:—

| | |
|---|---|
| February .... .... .... | 1.77 inches. |
| March .... .... | 0.82 do. |
| April .... .... .... | 1.08 do. |
| May .... .... .... | 0.62 do. |
| June .... .... .... | 3.60 do. |
| July .... .... .... | 3.88 do. |

It is evident from the yield data that both varieties withstood extremely well this prolonged period of low rainfall.

The difference of 2.45 tons of ratoon cane to the acre in favour of B. 2935 cannot be established as statistically significant. The difference of 0.43 ton of sugar in favour of B. 2935, however, might be due to chance less than once in 20 times.

*Total Yield (Plants and Ratoons).*

In this experiment *the variety B. 2935 gave a yield to the acre of plants and first ratoons of 13.77 tons of cane and of 1.40 tons of sugar in excess of the standard variety S.C. 12/4.* Both differences might be due to chance far less than once in 100 times.

There are set out in Table II the results of a trial which include the varieties B. 726, P.O.J. 2878 and G. 119 as well as S.C. 12/4 and B. 2935. The yield data are of particular interest in that they afford (i) a comparison of the merits of these varieties when reaped as plant canes, both early and late during a dry crop season, and (ii) a measure of the effect of early and late reaping as plant canes on the yield of the first ratoons. Each value recorded in Table II is a mean for ten replicate plots.

The experimental area was dressed to the acre with 25 tons of pen manure and 3 cwts. of sulphate of ammonia as plant canes and 2 cwts. of sulphate of ammonia as first ratoons.

*Plant Canes* (2).

The plant canes on two of the Latin squares were reaped in February 1935, *i.e.* early in the dry season. The plant canes on the two remaining Latin squares were reaped in May, 1935, *i.e.*, late in the dry season. In this experiment the variety P.O.J. 2878 alone increased in yield during the interval between the early and late reapings. The varieties B. 2935 and G. 119 suffered very severely from the drought conditions during this interval, losing in weight to the acre six and ten tons of cane, respectively. S.C. 12/4 and B. 726 suffered less severely losing from two to four tons of cane to the acre.

*First Ratoons.*

The ratoon canes on all plots began to dry out very early in the crop season. Consequently all plots were of necessity harvested during the first half of February 1936, irrespective of the time of harvesting of the plant canes. The life period of the first ratoons which were reaped as plant canes early in the dry season of 1935 therefore was 11½ months, whereas the life period of the first ratoons reaped late as plant canes was only nine months.

As the wet season of 1935 did not commence until July, the rainfall during the first four months of the life of the ratoon canes reaped early as

**Table II.—A comparison of varieties under conditions of early and late reaping as plant canes.**

*Estate*: College *Soil*: Sandy loam.
*Planted*: 7/11/33.
*Reaped*: 21/2/35 (early) and 11/5/35 (late) as plant canes, 7/2/36 as first ratoons (all plots).
*Rainfall*: 59 inches (14¾ months), 66 inches (17½ months), as plant canes, 43 inches (11½ months), 40 inches (9 months), as first ratoons.
*Layout*: Four 5 × 5 Latin squares.

| Variety. | Yield of cane (tons per acre). | | | | | | Yield of sugar (tons per acre). | | |
|---|---|---|---|---|---|---|---|---|---|
| | Early reaping as plants. | | | Late reaping as plants. | | | Early reaping as plants. | | |
| | Plants 1933-5 | 1st R. 1935-6 | Total 1933-6 | Plants 1933-5 | 1st R. 1935-6 | Total 1933-6 | Plants 1933-5 | 1st R. 1935-6 | Total 1933-6 |
| B. 2935 .. | 39.63 | 17.00 | 56.63 | 33.30 | 16.42 | 49.72 | 4.25 | 1.46 | 5.71 |
| P.O.J. 2878 .. | 37.26 | 16.32 | 53.58 | 39.00 | 16.31 | 55.31 | 3.75 | 1.37 | 5.12 |
| B. 726 .. | 33.39 | 14.81 | 48.19 | 30.01 | 13.55 | 43.56 | 3.68 | 1.36 | 4.99 |
| G. 119 .. | 36.20 | 16.77 | 52.97 | 26.23 | 17.14 | 43.38 | 3.37 | 1.26 | 4.63 |
| S.C. 12/4 .. | 31.71 | 11.58 | 43.30 | 29.66 | 13.95 | 43.61 | 3.19 | 0.88 | 4.07 |

plants was very low. The rainfall conditions were more favourable during the early life of the ratoon canes reaped late as plants.

Rainfall at College Estate in 1935 was:—

| | |
|---|---|
| March .... .... .... | 1.25 inches. |
| April .... .... .... | 1.45 do. |
| May .... .... .... | 0.90 do. |
| June .... .... .... | 1.95 do. |
| July .... .... .... | 5.45 do. |

*Early reaping as plant canes.*

Differences in yield of cane for the first ratoons must exceed 1.43 tons to the acre to be statistically significant. *There is nothing to choose between the yields of cane given by the ratoons of the varieties B.* 2935, *P.O.J.* 2878 *and G.* 119, *all of which are definitely superior to the yields for* B. 726 *and* S.C. 12/4. The variety S.C. 12/4 takes bottom place in the list with a yield of 5.42 tons cane to the acre less than B. 2935.

Differences in yield of sugar for the first ratoons must exceed 0.17 ton to the acre to be due to chance less than once in 20 times. *B.* 2935 *heads the sugar list, giving a yield of* 0.20 *ton sugar to the acre more than G.* 119 *and* 0.58 *ton more than S.C.* 12/4. P.O.J. 2878, and B. 726 (by virtue of the good quality of its juice), take equal second place on the list. The yield of sugar for S.C. 12/4 is significantly smaller than that for any of the other varieties.

*Late reaping as plant canes.*

Differences in yield of cane for the first ratoons must exceed 1.76 tons to the acre to be due to chance less than once in 20 times. *There is again nothing to choose between the ratoon yields for the varieties B* .2935, *P.O.J.* 2878 *and G.* 119, all of which are significantly larger than the yields for *B.* 726 and S.C. 12/4.

Circumstances prevented measurement of yield of sugar for the ratoon canes reaped late as plants.

It is of interest that under the conditions of this experiment the yields of the 11½-months' ratoon canes, which were harvested early as plants, were no greater than the yields of the 9-months' ratoon canes which were harvested late as plants.

*Total Yields (Plants and First Ratoons).*

*Early reaping as plants.*

Differences in total yield of cane to the acre exceeding 3.50 tons and 4.72 tons might be due to chance less than once in 20 and once in 100 times, respectively. *The variety B.* 2935 *gave a yield of plant and ratoon canes which is larger than any of the other varieties and significantly larger than the total yields for G.* 119, *B.* 726 *and S.C.* 12/4. P.O.J. 2878 and G. 119 gave significantly larger yields than B.726 and S.C. 12/4. *S.C.*12/4 *gave a significantly smaller yield of cane than any of the other varieties.*

Differences in total yield of sugar to the acre exceeding 0.33 ton and 0.44 ton might be due to chance less than once in 20 and once in 100 times, respectively. *The variety B.*2935 *gave a significantly larger total yield of sugar than any other variety.* P.O.J. 2878 and B. 726 gave yields of sugar definitely superior to those of G. 119 and S.C. 12/4. *S.C.* 12/4 *gave a significantly smaller yield of sugar than any other variety.*

*In this experiment B.* 2935 *gave a total yield of* 13.33 *tons of cane and* 1.64 *tons of sugar more to the acre than S.C.* 12/4 *when reaped early in crop as plant canes and as first ratoons, a result which is in close agreement with that obtained at Camp Estate.*

*Late reaping as plants.*

Differences in total yield of cane to the acre exceeding 4.24 tons and 5.72 tons might be due to chance less than once in 20 and once in 100 times, respectively. *P.O.J.* 2878 *gave a significantly larger total yield of cane than any other variety, including B.* 2935, primarily because of the superior manner in which the plant canes of the Java variety withstood the drought conditions which prevailed during the period between the early and late reapings in 1935. *There is little to choose between the total yields of cane for the varieties B.* 726, *G.* 119 *and S.C.* 12/4, *which are significantly smaller than the yields for P.O.J.* 2878 *and B.* 2935.

In this experiment P.O.J. 2878 and B. 2935 gave total yields of 11.70 tons and 6.11 tons of cane, respectively, in excess of S.C. 12/4, under conditions of late reaping as plant canes.

There are recorded in Table III the yield data for another experiment which includes the varieties S.C. 12/4, B. 2935, B. 726, P.O.J. 2878 and G. 119. This trial was laid down in 1934 in the form of two Latin squares. One of the squares was reaped early in the crop season of 1936, and one late in this crop season, as plant canes.

**Table III.—A comparison of varieties under conditions of early and late reaping as plant canes.**

*Estate*: Douglas. *Soil*: Sandy loam.
*Planted*: 13/11/34.
*Reaped*: 24/2/36 (early), 28/4/36 (late).
*Rainfall*: 55 inches (15½ months), 59 inches (17½ months).
*Layout*: Two 5 × 5 Latin squares.

| Variety. | Yield of plant canes (tons per acre). | | | | | |
|---|---|---|---|---|---|---|
| | Early reaping. | | Late reaping. | | Average values. | |
| | Cane. | Sugar. | Cane. | Sugar. | Cane. | Sugar. |
| B. 2935 .. | 36.56 | 3.54 | 27.27 | 2.79 | 31.91 | 3.16 |
| P.O.J. 2878 .. | 34.31 | 3.22 | 26.32 | 2.68 | 30.31 | 2.95 |
| G. 119 .. | 35.41 | 3.01 | 25.29 | 2.45 | 30.35 | 2.73 |
| B. 726 .. | 25.55 | 2.68 | 22.18 | 2.32 | 23.86 | 2.50 |
| S.C. 12/4 .. | 27.22 | 2.56 | 23.31 | 2.39 | 25.26 | 2.47 |

The experimental area was dressed to the acre with 25 tons of pen manure and 3 cwts. of sulphate of ammonia.

The rainfall at Douglas Estate during the dry season following planting was:—

| | | | |
|---|---|---|---|
| January | .... | .... | 2.70 inches. |
| February | .... | .... | 2.30 do. |
| March | .... | .... | 1.00 do. |
| April .... | .... | .... | 1.10 do. |
| May .... | .... | .... | 1.35 do. |
| June .... | .... | .... | 2.40 do. |

*Plant Canes.*

*Early reaping.*

A fair amount of rotted cane was found on the plots of the varieties B. 726 and S.C. 12/4 even at the time of the early reaping. This may in part account for the low yields of plant canes given by these varieties (*c.f.* Table II).

Differences in yield of plant cane must exceed 4.69 tons to the acre to be due to chance less than once in 20 times. *There is little to choose between the yields of cane for the varieties B. 2935, P.O.J. 2878 and G. 119, all of which are significantly larger than the yields for B. 726 and S.C. 12/4.*

Differences greater than 0.46 ton sugar to the acre might be due to chance less than once in 20 times. *The varieties B. 2935 and P.O.J. 2878 gave significantly larger yields of sugar than B. 726 and S.C. 12/4.*

For the early reaping, the plant canes of *B.* 2935 gave 9.35 tons cane and 0.98 ton sugar more to the acre than S.C. 12/4 (c.f. Tables I and II).

*Late reaping.*

The recorded differences in cane and sugar for the late reaping of the plant canes cannot be established as statistically significant because of the large variation in yield between corresponding plots. This variation is probably due in the main to irregular drying out of cane from plot to plot.

In this experiment the plant canes of the variety P.O.J. 2878 did not successfully withstand the drought conditions during the interval between the early and late reapings, as in the experiment at College Estate (Table II). The heavier yielding varieties B. 2935, P.O.J. 2878 and G. 119 each lost in weight more than eight tons of cane to the acre during this interval. The lighter-yielding varieties B. 726 and S.C. 12/4 lost from three to four tons of cane (*c.f.* Table II). The total rainfall during the period of two months between the early and late reapings was 3.78 inches.

*Average yields (early and late reapings).*

On the average the varieties B. 2935, P.O.J. 2878 and G. 119 gave approximately equal yields of plant cane greatly in excess of those for B. 726 and S.C. 12/4. B. 2935 gave a significantly larger average yield of sugar than the varieties G. 119, B. 726 and S.C. 12/4. P.O.J. 2878 gave a significantly larger average yield than B. 726 and S.C. 12/4.

THE WET AREAS.

B.H. 10(12) is the variety predominantly grown in the wet areas. P.O.J. 2878 and B. 374 are grown to a limited extent. Data are set out in Table IV which enable a comparison of the yield of cane and sugar given by plant and ratoon canes of these varieties with the seedling B. 726.

**Table IV. — A comparison of varieties under conditions of adequate rainfall.**

*Estate*: Molineux. *Soil*: Sandy loam.
*Planted*: 2/11/33.
*Reaped*: 26/2/35 as plant canes, 2/4/36 as first ratoons.
*Rainfall*: 88 inches (16 months) as plant canes.
57 inches (13½ months) as first ratoons.
*Layout*: Two 4 × 4 Latin squares.

| Variety. | Cane (tons per acre). | | | Sugar (tons per acre). | | |
|---|---|---|---|---|---|---|
| | Plants 1933-35 | 1st R. 1935-36 | Total 1933-36 | Plants 1933-35 | 1st R. 1935-36 | Total 1933-36 |
| B.H.10 (12) .. | 44.68 | 41.75 | 86.43 | 4.71 | 5.02 | 9.73 |
| B. 726 .. | 40.33 | 39.84 | 80.17 | 4.64 | 4.93 | 9.57 |
| P.O.J. 2878 .. | 44.28 | 35.52 | 79.81 | 4.60 | 4.30 | 8.90 |
| B. 374 .. | 46.25 | 39.14 | 85.39 | 4.51 | 4.30 | 8.81 |

The experimental area was dressed to the acre with 25 tons of pen manure and 3 cwts. of sulphate of ammonia as plant canes and 4 cwts. of sulphate of ammonia as ratoons.

*Plant Canes (2).*

B. 726 gave a significantly smaller yield of plant cane than the varieties B.H. 10(12), P.O.J. 2878, and B. 374. The germination of B. 726 was less satisfactory than that of the other varieties, however. Differences in yield of sugar cannot definitely be ascribed as varietal and may be due to chance factors such as soil variation.

*First Ratoons.*

The rainfall on the experimental area during the early life of the first ratoons was:—

| | | | |
|---|---|---|---|
| February (26th-28th) | .... | | 0.21 inches |
| March | .... | .... | 1.42 do. |
| April .... | .... | .... | 1.52 do. |
| May .... | .... | .... | 3.07 do. |
| June .... | .... | .... | 3.10 do. |

Differences in yield of first ratoons which exceed 2.24 tons cane to the acre might be due to chance less than once in 20 times. *All the varieties ratooned well, with the exception of P.O.J. 2878 which gave a significantly smaller ratoon yield than any of the other varieties.* The ratoons of P.O.J. 2878 arrowed freely and were pithy at the time of reaping. *B.H. 10(12) alone gave a significantly larger yield than B. 374.*

*There is little to choose between the yields of sugar given by the first ratoons of B.H.* 10(12) *and* B. 726. *Both varieties gave from* 0.6 *to* 0.7 *ton more sugar to the acre than P.O.J.* 2878 *and B.* 374, a difference which might be due to chance far less than once in 100 times.

*Total Yields (Plants and First Ratoons).*

Differences greater than 3.86 tons of cane to the acre might be due to chance less than once in 20 times. The varieties B.H.10(12) and B. 374 gave total yields of plants and ratoons in excess of those for P.O.J. 2878 and B. 726 by five to six tons of cane to the acre.

Differences greater than 0.59 ton sugar to the acre might be due to chance less than once in 100 times. The total yields of sugar for the varieties B.H. 10(12) and B. 726 are therefore definitely superior to those for P.O.J. 2878 and B. 374.

*From the standpoint of total yield of cane and sugar the variety B.H.* 10(12) *is superior to all others in this experiment.*

The data recorded in Table V enable a further comparison of the yields given by plant canes of the varieties B.H. 10(12), B. 726, and P.O.J. 2878 in the wet areas.

**Table V.—A comparison of varieties in a wet area.**

*Estate*: Mansion. *Soil*: Sandy loam.
*Planted*: 7/11/34.
*Reaped*: 27/3/36.
*Rainfall*: 73 inches (16¾ months).
*Layout*: Three 3 × 3 Latin squares.

| Variety. | Yield of plant canes (tons per acre). | |
|---|---|---|
| | Cane. | Sugar. |
| B. 726 .. .. | 40.06 | 4.57 |
| B.H. 10(12) .. .. | 38.97 | 4.20 |
| P.O.J. 2878 .. .. | 30.98 | 3.64 |

The experimental area was manured with 25 tons of pen manure and 3 cwts. of sulphate of ammonia to the acre.

The rainfall during the dry season following planting was:—

| | | | |
|---|---|---|---|
| January | .... | .... | 3.85 inches. |
| February | .... | .... | 2.78 do. |
| March | .... | .... | 1.00 do. |
| April .... | .... | .... | 1.44 do. |
| May .... | .... | .... | 2.74 do. |
| June .... | .... | .... | 2.38 do. |

*Plant Canes.*

The variety P.O.J. 2878 arrowed profusely. The individual canes of this variety were pithy, and were drying out rapidly as early as March (1936).

Differences in yield of cane exceeding 2.65 and 2.77 tons to the acre might be due to chance less than once in 20 and once in 100 times, respectively. The yield of cane for the variety B. 726 exceeded that for B.H.10(12), but the difference of 1.09 tons to the acre might be due to chance factors. *The yields of cane for B.* 726 *and B.H.* 10(12) *are greatly in excess of the yield for P.O.J.* 2878.

Differences in yield of sugar exceeding 0.33 ton and 0.48 ton to the acre might be due to chance less than once in 20 and once in 100 times, respectively. *B.* 726, *by virtue of the superior quality of its juice, gave a significantly larger yield of sugar than B.H.* 10(12). P.O.J. 2878 gave 0.93 ton of sugar to the acre less than B. 726 and 0.56 ton less than B.H. 10(12).

COMMENTS ON THE VARIETIES UNDER COMPARISON.

*The Dry Areas of the Lower Lands.*

Three experiments which include the varieties B. 2935 and S.C. 12/4, and two experiments which include B.2935, P.O.J. 2878, B. 726 and G. 119, have now been reaped under the new scheme.

*B.* 2935 *and S.C.* 12/4.

When reaped early in the crop season B.2935 gave yields of plant cane to the acre larger than S.C. 12/4 by 11.32, 7.92 and 9.35 tons, an average of 9.53 tons of cane. The corresponding differences in yield of sugar to the acre were 0.97 ton, 1.06 tons and 0.98 ton, an average of 1.00 ton. When reaped early in the crop season as plant canes and as first ratoons B. 2935 gave total yields of cane to the acre of 13.77 tons and 13.33 tons, and total yields of sugar to the acre of 1.40 tons and 1.64 tons in excess of S.C. 12/4. When reaped late in the crop season B. 2935 gave yields of plant cane of 3.64 and 3.96 tons, and yields of sugar of 0.49 (2) and 0.40 ton, more to the acre than S.C. 12/4. When reaped late as plant canes and early as first ratoons B. 2935 gave a total yield of 6.11 tons cane to the acre more than S.C. 12/4. *The variety B.* 2935 *would therefore appear definitely superior to S.C.* 12/4 *for the dry areas of the lower lands.*

The plant canes of B. 2935, however, lost heavily in weight if reaped late in the crop season on these areas. In one experiment the loss to the acre through late reaping amounted to 6.33 tons of cane and 0.63 ton of sugar (2). In the other it amounted to 9.29 tons of cane and 0.75 ton of sugar. *B.* 2935 *cannot therefore be considered as a satisfactory variety for late reaping as plant canes on the dry areas.* The data for the experiment at College Estate also suggest that it is unsuited for late reaping as ratoons.

*B.* 2935 *and P.O.J.* 2878.

When reaped early in the crop season B. 2935 gave yields of plant cane slightly but not significantly superior, and yields of sugar significantly superior, to P.O.J. 2878 in both experiments. When reaped late B.2935 gave a yield of 5.70 tons of plant cane and 0.50 ton of

sugar less than P.O.J. 2878 in one experiment(2). In the other experiment the difference in yield of plant cane and sugar for the two varieties was not statistically significant. There was little to choose between the yields of cane and sugar for the ratoons of the varieties B.2935 and P.O.J. 2878 in the one experiment which has been reaped as ratoons.

*P.O.J. 2878 may find a place in the dry areas for late reaping as plant canes, but further experimental evidence is necessary before a definite decision can be made.*

*B. 2935 and B. 726.*

When reaped early in the crop season B. 2935 gave yields to the acre of 6.24 and 11.01 tons of plant cane and 0.57 and 0.86 ton of sugar larger than B. 726. When reaped late in the crop season B. 2935 gave yields of 3.29 and 5.09 tons of plant cane and 0.05 (2) and 0.47 ton of sugar in excess of B. 726. On the average B. 2935 gave better yields of first ratoons than B. 726.

*B. 726 would thus appear inferior to B. 2935 as a variety for the dry areas.*

*B. 2935 and G. 119.*

*The poor yields of sugar to the acre given by G. 119 render it definitely unsuitable as a competitor to B. 2935.*

*The Wet Areas.*

Three experiments which include the varieties B.H. 10(12), B. 726 and P.O.J. 2878, and two which include B. 374, have now been reaped under the new scheme.

*B.H. 10(12) and B. 726.*

B.H. 10(12) gave a significantly larger yield of plant cane than B. 726 only in one of the experiments. In this experiment the germination of B. 726 was poor. In one of the experiments B. 726 gave a significantly larger yield of sugar to the acre than B.H. 10(12) as plant cane. *Further tests are necessary to decide between the relative merits of B.H. 10(12) and B. 726 on the wet areas.*

*B.H. 10(12) and P.O.J. 2878.*

In two of the experiments P.O.J. 2878 gave significantly smaller yields of cane and sugar as plant canes than B.H. 10(12). In the third experiment it gave a significantly smaller yield of cane and sugar as first ratoons than B.H. 10(12). *B.H.10 (12) is undoubtedly a more satisfactory variety for the wet areas than P.O.J. 2878.*

*B.H. 10(12) and B. 374.*

B. 374 on occasion can give as large yields of cane as B.H. 10(12). In yield of sugar, however, it appears consistently inferior to B.H. 10(12).

**Time of Planting.**

In both dry and wet areas it is of importance to determine how early planting operations can begin without undue harm resulting to the young cane in the dry season which follows planting. Measured information has so far been obtained from two experiments designed to investigate this problem.

THE DRY AREAS OF THE LOWER LANDS.

The effect on yield of planting the variety B.H. 10(12) at monthly intervals extending from the middle of September to the middle of January, under very dry conditions, is recorded in Table VI.

**Table VI.—Effect on yield of time of planting of B.H. 10(12) under very dry conditions.**

*Estate* : Buckleys. *Soil* : Sandy loam.
*Variety* : B.H. 10(12). *Reaped* : 4/4/36.
*Layout* : Two 5 × 5 Latin squares.

| Time of planting. | Rainfall (ins.) | Yield of cane (tons per acre). |
|---|---|---|
| Mid. Sept. (1934) .. | | 13.10 |
| | 2.96 | |
| Mid. Oct. .. | | 14.57 |
| | 2.25 | |
| Mid. Nov. .. | | 17.95 |
| | 10.82 | |
| Mid. Dec. .. | | 20.65 |
| | 3.22 | |
| Mid. Jan. (1935) .. | | 22.00 |

The experimental plots were dressed to the acre with 2 cwts. of sulphate of ammonia and 1 cwt. of muriate of potash six weeks after planting, and 2 cwts. of sulphate of ammonia towards the end of the dry season of 1935.

The rainfall at Buckleys Estate during 1935 was extremely low.

| | | | |
|---|---|---|---|
| Jan. .... | 1.98 ins. | July .... | 4.38 ins. |
| Feb. .... | 1.57 ,, | August .... | 4.62 ,, |
| March .... | 1.05 ,, | Sept. .... | 3.02 ,, |
| April .... | 1.59 ,, | Oct. .... | 6.98 ,, |
| May .... | 1.54 ,, | Nov. .... | 5.06 ,, |
| June .... | 3.18 ,, | Dec. .... | 2.32 ,, |
| Jan.-June | 10.91 ins. | July-Dec. | 26.38 ins. |

The dry season following planting was exceptionally long and severe, only 10.91 inches falling in the first six months of the year. The annual total of 37.29 inches is 12.55 inches below the average for the period 1919-34.

*Under these conditions the yield of cane steadily and significantly increased as the time of planting was delayed.* The January planting gave a yield of 8.90 tons cane to the acre in excess of the September planting.

It is perhaps unfortunate that the variety B.H. 10(12) was used in this experiment. Under conditions of such low rainfall a measure of the effect of time of planting on the yield of a variety more suited to the dry area, *e.g.* B. 2935 would have been of great interest.

THE WET AREAS.

The data obtained for a similar experiment in the wet areas with the variety B.H. 10(12) are recorded in Table VII.

**Table VII.—Effect on yield of time of planting of B.H. 10(12) under wet conditions.**

*Estate*: Bellevue. *Soil*: Sandy loam.
*Variety*: B.H. 10(12). *Reaped*: 22/4/36.
*Layout*: Three randomised blocks of six treatments.

| Time of planting. | Rainfall (ins.) | Yield of cane (tons per acre). | |
|---|---|---|---|
| Mid. Aug. (1934) .. | | 39.32 | |
| | 4.32 | | |
| Mid. Sept. .. | | 40.77 | 40.71 |
| | 9.03 | | |
| Mid. Oct. .. | | 42.05 | |
| | 3.76 | | |
| Mid. Nov. .. | | 36.46 | |
| | 11.58 | | |
| Mid. Dec. .. | | 37.65 | 36.91 |
| | 5.06 | | |
| Mid. Jan. (1935) .. | | 36.61 | |

The experimental plots were dressed with 1 cwt. of sulphate of ammonia at the time of planting, 2 cwts. of sulphate of ammonia and 1 cwt. of muriate of potash six weeks after planting and 3 cwts. of sulphate of ammonia at the end of the dry season of 1935.

The rainfall at Bellevue Estate during 1935 was:

| | | | |
|---|---|---|---|
| Jan. .... | 3.73 ins. | July .... | 5.69 ins. |
| Feb. .... | 2.82 ,, | Aug. .... | 5.12 ,, |
| March .... | 1.19 ,, | Sept. .... | 5.54 ,, |
| April .... | 2.34 ,, | Oct. .... | 12.58 ,, |
| May .... | 3.40 ,, | Nov. .... | 10.37 ,, |
| June .... | 1.89 ,, | Dec. .... | 3.07 ,, |
| Jan.-June | 15.37 ins. | July-Dec. | 42.37 ins. |

The rainfall in the first six months was only two-thirds of the average during this period for the previous 20 years.

The area on which the experiment was laid down is somewhat variable in character. Consequently individual differences in yield cannot be established as statistically significant. The difference of 3.80 tons of cane to the acre between the average yields for the three early plantings and for the three late plantings, however, might be due to chance less than once in 20 times. According to these data *planting operations in the wet areas should be completed by the end of October if maximum yield of B.H. 10(12) is to be obtained.*

Acreages in the wet areas planted with the variety B.H. 10(12) during the months August to April of the season 1933-34 are recorded in Table VIII. The data are based on information obtained from 13 estates.

**Table VIII. — Monthly acreages planted with B.H. 10(12) in the wet areas during the season 1933-34.**

| Month 1933-34. | Acres planted. | Percentage of total. | |
|---|---|---|---|
| August .. | 13 | 1.6 | |
| September .. | 155¼ | 19.0 | 48.2 |
| October .. | 225½ | 27.6 | |
| November .. | 166¼ | 20.4 | |
| December .. | 132¾ | 16.3 | 51.8 |
| Jan.-April .. | 123½ | 15.1 | |

During this season the main planting months were September, October, November and December. Approximately half the area under B.H. 10(12) was planted later than October.

Field observations indicate that in the wet areas a much higher percentage germination is obtained with setts planted in September and October than with setts planted in November and December. It is probable that the material available for planting has become too mature for satisfactory germination by the end of October (1).

It is of interest that the rainfall recorded during the first six months of 1935 for the 'time of planting' experiment in the wet area was only 4.46 inches greater than for the corresponding experiment in the dry area. Nevertheless, early planting was a success in the wet area and a failure in the dry area.

**Distance of Spacing.**

The effect of varying the spacing distance within the row on yield of plant and ratoon canes has been measured in two experiments, one of which was laid down in a very dry area and the other in a moderately wet area. The distance between the rows of cane in both experiments was maintained constant at 4½ feet. The yield data for the plant canes of these experiments have previously been discussed (2).

THE DRY AREAS OF THE LOWER LANDS.

The data for the experiment on the very dry area are set out in Table IX. The variety planted was S.C. 12/4.

**Table IX.—Effect of spacing distance on total yield under very dry conditions.**

*Estate*: Canada. *Soil*: Sandy loam.
*Variety*: S.C. 12/4.
*Planted*: 6/12/33.
*Reaped*: 6/3/35 as plant canes, 7/2/36 as first ratoons.
*Rainfall*: 45 inches (15 months) as plant canes, 36 inches (11½ months) as first ratoons.
*Layout*: Four 3 × 3 Latin squares.

| Spacing distance. | Yield of cane (tons per acre). | | | |
|---|---|---|---|---|
| | Plants 1933-35 | 1st R. 1935-36 | Total 1933-36 | Diff. |
| 4½ ft. × 2 ft. .. | 31.80 | 18.26 | 50.06 | — |
| 4½ ft. × 3 ft. .. | 34.37 | 20.88 | 55.25 | 5.19 |
| 4½ ft. × 4 ft. .. | 36.15 | 21.26 | 57.41 | 7.35 |

The plant canes were given to the acre an early dressing of 25 tons of pen manure and a late dressing of 3 cwts. of sulphate of ammonia. The first ratoons were given 3 cwts. of sulphate of ammonia and 1 cwt. of muriate of potash to the acre.

*Plant Canes* (2).

The reductions in yield of plant canes resulting from spacings closer than four feet in the row are statistically significant. It will be recollected that rainfall during the life of the plant canes was very low.

*First Ratoons.*

The rainfall during the life of the ratoons also was low :—

| | | | |
|---|---|---|---|
| Mar. (1935) | 0.93 ins. | Sept. .... | 3.31 ins. |
| April .... | 1.04 ,, | Oct. .... | 11.31 ,, |
| May .... | 1.07 ,, | Nov. .... | 5.09 ,, |
| June .... | 1.17 ,, | Dec. .... | 1.60 ,, |
| July .... | 4.06 ,, | Jan. (1936).... | 1.95 ,, |
| Aug. .... | 4.43 ,, | | |
| | | Total .... | 35.96 ins. |

The monthly totals were less than two inches on six occasions. They exceeded $3\frac{1}{2}$ inches only on four occasions.

Differences in yield of the ratoons exceeding 1.76 tons of cane to the acre might be due to chance less than once in 100 times. The yield of ratoons on the plots with a spacing of two feet in the row is therefore significantly smaller than the yield on the plots with spacings of three feet and four feet. *Too close planting on light soils under conditions of limited rainfall can therefore not only adversely affect the yield of plant canes but also of the following crop of ratoons.*

*Plant and Ratoon Canes.*

Differences in total yield of plant and ratoon canes exceeding 3.71 tons are statistically significant. The total yields to the acre on the plots with three feet and four feet spacings are larger by 5.19 and 7.35 tons than the yield on the plots with a spacing of two feet.

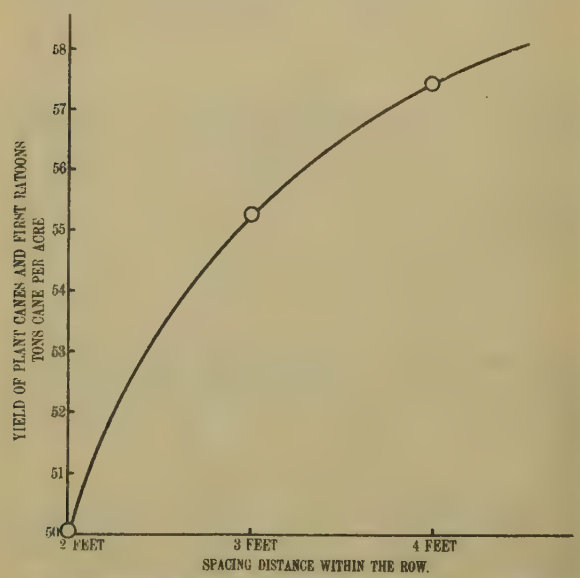


FIG. 1.—EFFECT OF SPACING DISTANCE WITHIN THE ROW ON YIELD OF S.C. 12/4 UNDER DRY CONDITIONS ON LIGHT SOILS. THE DISTANCE BETWEEN ROWS IS 4½ FEET.

The relationship between total yield and spacing distance for the variety S.C. 12/4 is graphically expressed in Figure I. *The trend of the curve suggests that the optimum spacing distance within the row on a very dry area of light soil lies in the region of $4\frac{1}{2}$ feet under the conditions which obtained.*

A Moderately Wet Area.

The yield data for the moderately wet area are recorded in Table X. The variety planted was B.H. 10 (12).

**Table X.—Effect of spacing distance on total yield under moderately wet conditions.**

*Estate* : Stapleton. *Soil* : Sandy loam.
*Variety* : B.H. 10(12).
*Planted* : 16/1/34.
*Reaped* : 2/5/35 as plant canes, 29/4/36 as first ratoons.
*Rainfall* : 66 inches ($15\frac{1}{2}$ months) as plant canes 55 inches ($11\frac{3}{4}$ months) as first ratoons.
*Layout* : Three 3 × 3 Latin squares.

| Spacing distance. | Yield of cane (tons per acre). | | | |
|---|---|---|---|---|
| | Plants 1934-35 | 1st R. 1935-36 | Total 1934-36 | Diff. |
| $4\frac{1}{2}$ ft. × 2 ft. .. | 37.64 | 23.52 | 61.16 | — |
| $4\frac{1}{2}$ ft. × 3 ft. .. | 38.58 | 25.18 | 63.76 | 2.60 |
| $4\frac{1}{2}$ ft. × 4 ft. .. | 38.35 | 24.99 | 63.34 | 2.18 |

The experimental area was dressed to the acre with 25 tons of pen manure and 3 cwts. of sulphate of ammonia as plant canes, and with 3 cwts. of sulphate of ammonia and 1 cwt. of muriate of potash as ratoons.

*Plant Canes* (2).

Differences in yield of the plant canes cannot be established as statistically significant.

*First Ratoons and Total Yields.*

Slightly smaller ratoon yields and total yields were obtained with the spacing distance of two feet in the row than with the wider spacings, but the differences cannot be definitely ascribed to spacing distance. It therefore remains open to doubt whether yield of B.H. 10(12) is increased by reducing the distance in the row below four feet under the conditions which obtained on the experimental area.

**Summary.**

There are recorded in this paper the results of a series of experiments, reaped in 1936, with varieties, with time of planting and with distance of spacing of sugar cane. The experiments were laid down under the auspices of the Sugar-Cane Investigation Committee of St. Kitts.

*Varieties.*

*Dry Areas.*

As plant canes and first ratoons the variety B. 2935 has given in general total yields of cane and sugar greatly in excess of the standard variety S.C. 12/4, and it would seem definitely advantageous to replace S.C. 12/4 by B. 2935 in the dry areas. B. 2935, however, can lose heavily in weight as plant canes if reaped late in the crop season.

The variety P.O.J. 2878 may find a place in dry areas for late reaping as plant canes, but additional experimental evidence is necessary before a final decision can be made as to its suitability for this purpose.

The varieties B.726 and G.119 appear definitely inferior to B. 2935.

*Wet Areas.*

Satisfactory yields of cane and sugar have been obtained from the variety B. 726 in those experiments in which it has germinated well. B. 726 may prove a competitor of the standard variety B.H. 10(12) under certain conditions in the wet areas.

The variety P.O.J. 2878 is undoubtedly less suited to the wet areas than B.H. 10 (12).

*Time of Planting (Plant Canes).*

*Dry Areas.*

Yield of the variety B.H. 10(12) was found steadily to increase as time of planting was delayed from September to January. This result should not be regarded as representative as B.H. 10(12) is not suited to the very dry conditions which obtained.

*Wet Areas.*

The average yield given by B.H. 10(12) when planted in August, September and October was found to be significantly greater than the average yield given by November, December and January plantings. It would seem that planting operations in the wet areas should be completed in October if maximum yield of B.H. 10(12) is to be obtained.

*Distance of Planting.*

*Dry Areas.*

In a very dry area the optimum planting distance within the row for the variety S.C. 12/4 appears to lie in the region of 4½ feet. Closer planting was found adversely to affect the yield of the plant canes and of the following ratoon crop.

*Wet Areas.*

In a moderately wet area a significant increase in the yield of plant and ratoon canes of variety B.H. 10(12) did not result from planting closer than four feet in the row.

The distance between the rows in the experiments in both dry and wet areas was 4½ feet.

**Acknowledgments.**

The authors are indebted to Mr. G. B. Gregory and Mr. J. M. Cave for assistance in laying down and reaping the experiments.

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## VERNALIZATION.

By F. G. Gregory and O. N. Purvis.

The phenomenon of 'vernalization', namely, the acceleration of ear formation in winter varieties of cereals by exposing the germinating seed to low temperature, is now well known.* The underlying cause of this effect of low temperatures is by no means clear. Enzymatic changes in the fruit external to the embryo have been postulated by Richter and others. Experiments to test such possible changes or hormone effects have been performed by Krasnoseljskaja-Maxomova in which endosperm of winter and spring varieties has been interchanged. Similar experiments have been repeated by Sereiskii and Sluckaja, and interchange of embryos has also been tried. The former investigator claims positive results which, however, the latter investigators failed to substantiate.

* Vernalization and Phasic Development of Plants. Bull. 17. Imperial Bureau of Plant Genetics.

Experiments recently carried out by us (the writers) have shown conclusively that excised embryos separated completely from the endosperm and grown on agar containing 2 per cent. glucose and mineral nutrients alone can nevertheless be vernalized in the same way as complete 'seeds'. Such separated embryos kept at 1°C. for six weeks and then planted out produced normal plants earing ten weeks later, whereas similar embryos kept at 18°C. until they had reached the same stage in development (coleoptile developed, but first leaf not emerged) showed no signs of 'shooting' after a further ten weeks of growth.

It would appear therefore that the 'cause' of vernalization by low temperature is entirely inherent in the embryo, and is not dependent in any way on the metabolism of the endosperm or aleurone layer. — (*Nature*, Vol. CXXXVIII, No. 3484, p. 249, "Letters to the Editor", 1936.)

# CROP PRODUCTS MANUFACTURE IN 1935*

## Oils, Fats, and Soaps; By R. Furness.

*Chemistry of Oils and Fats.*

Work on the fundamental chemistry of oils and fats has proceeded further during the year; the advances made during the past ten years have been summarised by Professor Hilditch in a notable Jubilee memorial lecture (*Chem. and Ind.*, pp. 139, 163, 184; 1935).

It is interesting to note that marine animal oils contain a complex mixture of unsaturated fatty acids of widely varying molecular weight, whereas the fats of land animals contain, broadly speaking, a much simpler class of fatty acids, namely palmitic, stearic, oleic and linoleic acids. Fats from animals representing intermediate stages in biological development seem to have a composition intermediate between these two extremes.

Recent investigations on the digestibility of fats provide an example of the direct applicability to industry of some academic researches. One important requirement of a fully acceptable edible fat is that it should be completely liquefiable at body temperature. The contrasting examples of cocoa butter and mutton tallow are therefore of considerable interest. Both fats contain approximately the same proportions of the same fatty acids, namely, 25 per cent. of palmitic acid, 35 per cent. of stearic acid, and 40 per cent. of oleic acid, but their component glycerides differ markedly. Thus, in cocoa butter, almost all the fat molecules contain oleic acid, and the whole fat melts at 30°C., well below body temperature. On the other hand, the distribution of oleic acid in mutton tallow is such that the melting point of the whole fat is much higher, namely between 45° and 50°C.

*Fatty Acids from Hydrocarbons.*

The British Empire controls a very large proportion of the world's supply of vegetable and animal oils and fats, apart from tung oil, which has not yet reached an economic stage of development within the Empire. These raw materials are glyceridic in composition, but there is a growing interest in the possibility of producing fatty acids directly from hydrocarbons. During the past 30 years, a great deal of experimental work has been carried out on the oxidation of paraffin wax to fatty acids, and it is still questionable whether the process can be applied technically. The I.G. Farbenindustrie A.G. have found that a product from paraffin wax (or other suitable mineral oil distillate), obtained by air oxidation at 120° to 150°C., in the presence of a suitable catalyst, such as a manganese soap, can furnish a reasonably high quality of soap-making fatty acids. The process consists in dissolving the oxidation product in a suitable solvent, and removing the fatty acids by saponifying with alkali solutions. Another method employed by the same company is to subject the crude mass resulting from the oxidation of wax to catalytic hydrogenation under conditions of high temperature and pressure, such as are employed in ammonia synthesis and coal liquefaction. By means of this process, the aldehydic and ketonic portions of the oxidised hydrocarbons are converted into alcohols, while the fatty acids remain unchanged. Thus, from an original hydrocarbon mixture, primarily converted by oxidation into a complex mixture of alcohols, esters, ketones, &c., together with unconverted hydrocarbons, a hydrogenated product is obtained consisting mainly of alcohols, acids and unchanged hydrocarbons. This mixture is sulphonated in such a way that only the alcoholic groups are affected, and the subsequent treatment of the sulphonated mass with alkali solution leads to the formation of a solution of alkali soaps and alkali salts, the unreacted hydrocarbons being removed for further use. It is claimed that the detergent mixture, when dried to a powder forms an attractive and useful product.

It is worth noting that naphthenic acids (which are by-products in the refining of certain petroleums), are now being produced in high quality. Their soap-making properties have been known for many years, but their intensely objectionable odour has caused the soap-maker to reject them. It is now claimed that specially-fractionated acids of unobjectionable odour are available for the manufacture of soap.

*Fats from Sugar.*

Another raw material which has from time to time received attention as a potential source of fats is sugar. Even during the War years, the Food Investigation Department of the D.S.I.R. was investigating this problem, but no economic application of the fermentation process has yet been made, in spite of the abundance and cheapness of molasses. During 1935, however, Ward (*Ind. and Eng. Chem.* 318, 1935) reported an investigation on the use of various species of *Aspergillus* and *Penicillium* for the production of fats from glucose. In one instance, *P. javanicum*, the mycelia contained as much as 41.5 per cent. of fat. The fat produced shows chemical and physical constants not unlike those of certain vegetable oils. Thus, the saponification value is 191 to 193, iodine value 78 to 88, unsaponifiable matter 1.02 to 2.0 per cent., saturated acids 32.5 to 34.6 per cent., and unsaturated acids 60.1 to 62.0 per cent. No technical application of this process has yet been made, nor does any appear likely under normal economic conditions, but it is pertinent to remember that, under the strained circumstances of war-time, glycerine was produced in considerable quantities by the fermentation of sugar.

*Beckmann Fermentation Process.*

Considerable interest has been shown in the application of the fermentation method of oil extraction, which was patented by J. W. Beckmann (*vide Tropical Agriculture*, XI, p. 155, 1934), but it is only during the past year that reliable results

* Abstracted from *The Industrial Chemist*, Vol. XII, Jan. and Feb., 1936.

of large scale experiments have become available. It seems that the process cannot yet be applied to all oil-bearing materials, and, even in the most favourable instances, the advantages over established methods have still to be proved. It is stated that the Beckmann process liberates in five days 88 per cent. of the oil from copra, 79 per cent. of the oil from walnuts, and 65.5 to 78 per cent. of the oil from cedar nuts. With sunflower and apricot kernels, the yield is much lower, and the methods fail with hemp, castor, mustard and maize seeds.

* * *

**Rubber; By S. A. Brazier.**

During the whole of 1935, the International Rubber Regulation Scheme for controlling the output of rubber from the East has been in operation. Under this scheme, which was announced in April, 1934, quotas were established for the more important rubber-producing areas, covering a period of years, and involving approximately 97 per cent. of the world's present rubber production. The present position is somewhat uncertain, and in some quarters definite anxiety exists as to the future of restriction. The danger spot is the difficulty in controlling the output of the natives of the Dutch East Indies.

A company has recently been established to produce powdered rubber on a commercial scale. In *Rubber Age* (New York) pp. 29, 37, 1935, a description is given of the plant, which has a capacity of three tons per day. The latex is sprayed on to a heated moving belt made of stainless steel, which passes through a chamber 100 feet long, maintained at a temperature varying from 90 to 120°C. The latex is dehydrated to form small globules of dry rubber and zinc stearate is sprayed on to it in order to prevent sticking, a proportion of from 3 to 5 per cent. being used.

A comprehensive survey of the variability encountered in typical grades of plantation rubber has been carried out by A. E. Warner. From the results obtained, roll brown crepe rubber was considered to show the greatest variation and plantation sheet to be the most uniform.

As regards synthetic rubber, interest still runs high in the success of these rubber-like materials, and rumour has it that Soviet Russia has started extensive manufacture of a product allied to that produced by the Du Pont Company of America. The latter company announced in October that a new plant is now in operation, with a production capacity of one million pounds per month. Arising from these and similar investigations, a new plastic material has been produced under the name of "Keroseal". Although it differs from rubber in chemical composition, its characteristics can be varied by suitable compounding from those of materials having properties similar to ebonite to those of a jellied rubber cement.

Perhaps the most striking feature of the year is the development of commercial applications of the chemical reaction products of rubber, and these have been reviewed by W. J. S. Naunton in a paper read before the Plastics Group of the Society of Chemical Industry (*J.S.C.I.*, 54, p. 565, 1935). The production of chlorinated rubber and of rubber hydrochloride is now being developed as a moisture-proof wrapping material, under the name of "Pliofilm". Chlorinated rubber has also been used in Java sugar factories to protect machinery against sulphurous acid. The report of the Rubber Research Institute of Malaya for 1934 describes experiments carried out on the use of paints and anti-corrosive materials to protect the inside of latex drums, and it is stated that preparations of chlorinated rubber have given excellent results on test. They dry quickly and prevent discoloration of the latex, and are not badly affected by immersion in latex. The Harrington Paint Co., of East Cleveland, Ohio, has also announced the production of a new rubber paint which gives a non-inflammable and tough film. Removal of rust is not only unnecessary but undesirable, a fact which is in itself important. It is claimed that this paint is unusually resistant to the action of acids and alkalies, and that exposure to sunlight has a beneficial effect upon it.

H. P. and W. H. Stevens have carried out some work on "Rubbone" which may have interesting applications. If rubber that has been dissolved in white spirit containing a little cobalt linoleate is aerated at elevated temperatures—*e.g.* 80°C.—the dissolved material gradually becomes resinous, and shows increasing solubility in ether. "Rubbone" is the resinous product obtained by aerating to a stage when a sample shows rapid sedimentation, leaving a clear supernatant solution of the oxidised material free from cobalt. It is a viscid, amber semi-solid, which is of particular value for the impregnation of electric wire coils, because of its fluidity at elevated temperatures. On baking, "Rubbone" sets firmly and the surface "case-hardens", whereby it becomes resistant to water and oil, and may thus be used as an electrical insulator. It is also of value for application in varnishes, and as an adhesive.

In view of the interest which is being taken in the production of petrol fuels from coal, the work of Crawley and King (*J.S.C.I.*, 54, p. 117T, 1935) is of importance. These investigators have shown that rubber is amenable to hydrogenation cracking, with the production of commercially-useful products. Under suitable conditions, a motor spirit alone was obtained, or alternatively, a motor spirit, fuel oil, and lubricating oil, depending on the temperature of treatment. The authors conclude that rubber would have to be available at a price much below existing market conditions for its utilisation in this manner to become a commercial proposition. Furthermore, Stevens and Donald (*Bull. R.G.A.* Vol. XVII, p. 213, 1935) have found that the addition of crude rubber to standard mineral oils improves their lubricating properties. The addition of from two to five per cent. of rubber increases the viscosity without unduly influencing this property at low temperatures.

D. W. D.

# STUDIES IN WEST INDIAN SOILS.

By F. Hardy.
*Imperial College of Tropical Agriculture, Trinidad.*

Investigations into the origin, classification, properties and agricultural relationships of the soils of the West Indies region have occupied a great deal of the time and facilities of the Chemistry Department of the College since its inception in 1922. Indeed, the earliest attempts to bring together the available information concerning the soils of the West Indies, and to extend our knowledge of their origin and crop relationships within the different insular areas were made before the College was founded, and whilst the Imperial Department of Agriculture was still in existence, with headquarters in Barbados.

(1) The first publication describing West Indian soils was entitled "*The Soils of Dominica, their Genesis and Fertility, considered in Relation to Reaction*". It formed an article in the now defunct *West Indian Bulletin*, Vol. XIX, issued in 1922. It was based mainly on geological considerations, and involved a study of soil acidity in its possible bearing on the growth of the cacao crop and the lime crop. In the year 1920, when this investigation was undertaken, colorimetric methods for determining soil reaction by means of the new pH indicators elaborated by Clark and Lubs had only just been perfected. One of the main reasons for studying the soils of Dominica at that period was to apply the new technique and the newer knowledge of the rôle of acidity in soil fertility to specific crop problems and to questions of soil formation from different kinds of parent rock materials exposed to different amounts of rainfall. The investigation was one of the first of its kind to be initiated within any special area for such purposes, but it cannot be claimed to have been exhaustive, and the soils of Dominica still offer innumerable problems awaiting detailed study.

(2) The second publication concerning West Indian Soils was entitled "*The Soils of Montserrat their Natural History and chief Physical Properties, and the Relationship of these to the Problem of Die-Back of Lime Trees*". It appeared also in the *West Indian Bulletin*, Vol. XIX, 1922, pp. 189-213. The chief object of the investigation which forms the topic of this second paper, was to study the environmental conditions associated with the dying-back of twigs of lime trees, and to attempt some explanation of its incidence. The field work was performed in collaboration with the Plant Physiologist of the Imperial Department of Agriculture, Dr. T. G. Mason, later the first Professor of Botany at the College, and now Plant Physiologist to the Cotton Growing Corporation at their Research Station in Trinidad. Mason demonstrated a distinctive difference in the zonation of the young woody tissues of lime trees exhibiting the die-back condition and that of the wood of normal healthy trees. This difference could approximately be correlated with differences in the moisture conditions of the environments of the two contrasted kinds of trees, as decided by topography, protection from drying winds, and physical type of soil which decide its permeability to water. Physical soil-type was further found to be an expression of geological origin, so that the account of the soil aspects of the problem involved a brief discussion of the genesis of the soils of Montserrat. Its main purpose was nevertheless a study in crop ecology.

(3) Between the years 1922 and 1930, the organisation of the Chemistry Department of the College, the preparation of courses of teaching, the study of certain fundamental problems of Soil Physics, and the initiation of researches into the Froghopper problem of sugar-cane in Trinidad delayed further the study of West Indian soils along the lines already initiated. Preliminary work on the soils of cacao and forest lands in Trinidad and Tobago conducted during this period (mainly with a view to providing subjects for the dissertations of specialist Post Graduate students of chemistry) eventually culminated, however, in the publication in February 1931, of the first of a new series of "Studies in West Indian Soils", namely, No. III, "*The Cacao Soils of Tobago*", in which the collaboration of two Post Graduate students, Messrs. C. G. Akhurst and G. Griffith was involved. This publication formed a supplement to the College Journal, *Tropical Agriculture*, Vol. VIII, 1931. Its general arrangement, scope and method of presentation of field and laboratory data were somewhat novel; they have been retained more-or-less unchanged up to the present time in succeeding articles or reports, conveniently referred to as "grey-books" on the Soils of the West Indies.

In this new series of soil studies initiated in 1928, a *profile method* of soil examination has been introduced and developed. Selected sites are explored by digging six-foot pits. The soil section thus exposed generally displays at its base the more-or-less unaltered parent rock. In many cases, ten-foot pits (such as are favoured by oil geologists in Trinidad) would have been preferable, but they are much more expensive to dig, and more difficult to sample. The profile is marked out into layers differentiated by changes in appearance and other easily-discernible features, except where the changes are uniformly graded, in which case, arbitrary subdivision into multiples of three inches is generally made. The surface soil, containing the bulk of the "feeding roots" of crop plants or forest trees, is more minutely

subdivided, for example, into layers of the following successive depths :—0-1½, 1½-3, 3-6, 6-9 9-12, 12-18 and 18-24 inches, below which the deep subsoil is marked out into foot layers. A single six-foot profile may thus comprise between eight and 12 different layers, each of which is described and sampled separately. Full notes are made at the time of sampling on the more obvious features of the soil, according to a descriptive nomenclature and a simple colour chart that have been evolved for the purpose. The individual soil samples are separately collected, bagged and labelled, and eventually transported to the laboratory, where they are air-dried, pulverised and sifted prior to detailed laboratory study.

The *methods of laboratory analysis* include both physical and chemical routine determinations. They have been specially selected, exhaustively tested, and sometimes modified in order to render possible the examination of very large numbers of soil samples in a uniform manner, involving a minimum expenditure of time. Progressive accounts of the methods finally applied are given in the published reports or articles describing the studies in West Indian Soils since the inception of the soil profile procedure in 1928. By the end of the year 1935, some 380 soil profiles in various parts of the British West Indies region had been dealt with in this manner, including the detailed examination of some 3,300 separate soil samples, and the work is still proceeding. This achievement has been possible mainly because of the existence of exceptionally suitable laboratory facilities provided by the College, and the organisation of a reliable staff of junior laboratory assistants working under the direction of a highly qualified analyst (Mr. G. Rodriguez). The junior staff is recruited mainly from youths of East Indian descent who have previously received an all-round elementary education in the schools of Trinidad.

The chief advantage of the rapid accumulation of a large mass of field and laboratory data lies in the fact that it permits detailed comparisons to be drawn between soils of different origins, formed under different climatic conditions, and subject to differing degrees of alteration through exploitation or utilisation for the growing of various types of agricultural crops. Thus, it has recently been found possible to diagnose with a fair degree of reliability the nutrient conditions of any particular type of soil in relation to the growing of cacao, citrus, banana, arrowroot and sugar-cane in the West Indies region. Certain "*limits of adequacy*" with regards to soil nitrogen, phosphate and potash have been provisionally established for each of these crops, and the information is available for application to regions outside the West Indies. How far the tentative numerical relationships and the diagnostic features of suitable and unsuitable ("good" and "bad") soils may apply elsewhere, is a subject for future consideration when the methods have been more widely applied. The co-operation of soil chemists working in other tropical countries is being sought, and plans are being suggested for the examination in the College laboratories of representative soil samples imported from remote regions such as West Africa. In attempting to establish relationships between soil factors and crop productivity, full use is made of yield data and the analysis of yield, such as have been developed for the cacao crop by the College Department of Economics under Professor C. Y. Shephard.

The soil data not only have proved serviceable in the diagnosis of soil conditions; they have also yielded much information concerning the processes of soil formation. The methods differ fundamentally from those employed by other schools of pedology, in that the soil profile is described, not simply as a morphological unit on appearance and structure alone, but mainly in terms of determinable physical and chemical constants. Thus, the laboratory values enable one to describe the texture profile, the reaction profile, the organic matter and nitrogen profile, the soluble salt profile, and the available phosphate and potash profile, as separate, though related, entities. Such physical and chemical descriptions of the soil profile, augmented by special laboratory determinations of exchangeable bases in representative, composite surface soil samples, and by complete chemical analyses of parent rocks, together with, in some cases, that of clay fractions, provide much more reliable information regarding the nature and effects of the processes of soil formation than mere inspection alone. By their employment and application, soil profiles may the more accurately be compared and classified. The numerical data for the successive layers of soil of each profile may be set out in columns of colours on *profile charts*, which include a column of actual specimens of the soil itself, mixed with transparent varnish and painted on to the cards. A scheme of colours for most of the determined soil constants has been devised for use in the preparation of these profile charts. Sets of completed charts are filed for future reference.

Referring again to the third article of the Studies in West Indian Soils, namely "*The Cacao Soils of Tobago*", the soil profile data clearly indicated striking differences between "good" and "bad" cacao soils, the accepted definition of "good" soil being one which supports mature cacao trees yielding over eight bags (each of 165 lb. weight) of dried cacao beans per 1,000 pickets or tree sites. Two chief factors appeared to account for high yielding capacity in the better cacao soils of Tobago, namely, (1) a high nutrient status (as estimated by electrical conductivity of water extracts of soil), and (2) a relatively high ratio of carbon to nitrogen in the organic matter contained in the surface six-inch layer of soil.

At the time when the Tobago cacao soils were being examined, individual determinations of available phosphate and potash had not been introduced into the routine laboratory work, so

that the specific nutrient factors of the soil could not then be identified. Later investigations, not yet published, have demonstrated that many of the Tobago soils are *very deficient in potash*, which seems to be associated with a well-defined leaf symptom, described as "*marginal leaf-scorch of cacao*". (See Fourth and Fifth Annual Report on Cacao Research for 1934 and 1935.) This symptom was first noted by Mr. J. A. McDonald (Chemist for Cacao Research) in 1933, in sand cultures of cacao seedlings treated with a nutrient solution lacking potassium. It has since been observed widespread in the field in various parts of Trinidad and Tobago, particularly on trees growing on soils containing less than a certain critical amount of available potash, as measured by a standard laboratory method. Some of the Tobago cacao soils are also deficient in available phosphate; deficiency in this nutrient seems to diminish the uptake of potash, so that, in certain cases, the effect of these two nutrients appears to be interdependent.

High ratio of carbon to nitrogen indicates an early stage in the decomposition of leaf and root vegetable débris; its association with high yields of cacao was originally noted for the cacao soils of Tobago by Dr. G. Griffith whilst attempting to correlate yield data with various soil factors. The reason for this striking correlation (which has since been conclusively demonstrated for the cacao soils of Grenada and of Trinidad) is difficult to find, but a suggestion that it is directly concerned in the prevalence of *mycorrhiza* in the soil, which is causally connected with the ability of the cacao root system to absorb nourishment from the soil, has received some verification from the work of Mr. E. E. Pyke, published in the Fourth Annual Report on Cacao Research, 1934, pp. 41-48. It is evident from these observations that the study of the cacao soils of Tobago has provided numerous promising lines of investigation, and has educed many suggestive ideas, so that the selection and application of the methods employed therein have been amply justified.

(4) The fourth article of Studies in West Indian Soils concerns *the Cacao Soils of Grenada*; it was published in December, 1932. The soils of Grenada have been formed from andesitic and basaltic lavas, and from their pyroclastic or fragmental equivalents (agglomerates and tuffs), though many of them belong to the river alluvial type, derived from the same volcanic parent materials. They are therefore somewhat different from the soils of Tobago, which have been formed from a more acidic kind of igneous rock, namely diorite, and from metamorphic rocks (mostly schists) that resemble somewhat the rocks of the Northern Range of Trinidad. Furthermore, the greater altitude and consequently the greater rainfall of the interior lands of Grenada have brought about a greater degree of rock alteration, weathering and leaching than have occurred in Tobago, so that the Grenada soil profiles are generally much more "mature" and more highly stratified, or differentiated into layers, than those of Tobago. Nevertheless, the same features distinguish the "good" cacao soils from the "bad".

The individual soil samples collected in Grenada were all analysed for available phosphate. This additional method of laboratory examination, applied for the first time as a routine procedure, revealed the new fact that *phosphate* is characteristically deficient in the poorer-yielding cacao soils of Grenada. These poorer soils generally occur at the greater elevations in areas of high rainfall; doubtless intense leaching has here deprived the soil of a large part of its content of phosphate and of lime, and has thus produced highly acidic conditions in the surface layers, as well as a marked deficiency of available phosphate. The chief features differentiating "good" from "bad" cacao soils in Grenada are their higher carbon/nitrogen ratios and their higher contents of available phosphate. These two relationships with yield data have been established by statistical analysis. Other factors, such as deficiency of potash and highly acidic reaction, may also have contributed to the low yielding capacity of some of the poorer upland soils.

(5) The fifth article of the series is entitled "*The Sugar-Cane Soils of Antigua*". It was published in April 1933. Its scope and main findings differ considerably from those of the preceding studies of cacao soils formed from igneous rock materials. The soils of Antigua are mostly derived from somewhat abnormal kinds of sedimentary rocks, including saline aqueous tuffs and highly calcareous marls and soft limestones. They are characterised by their highly alkaline reaction, due to the facts that either they contain excessive amounts of free calcium carbonate (limestone and marl soils), or they belong to the category of "black alkali soils" (slightly calcareous, saline, sedimentary tuff soils). The dry climate of Antigua (rainfall 40 to 30 inches a year) is conducive to the development and perpetuation of such soil-types, and the problems associated with their successful utilisation, even for the purpose of producing the widely-tolerant sugar-cane crop, are among the most difficult and perplexing that the agriculturist has to face. They require very careful tillage, and the question of their proper manuring needs special consideration, and entails cautious methods of experimental approach. The various aspects of their handling and treatment are now being actively studied in the field by the Agricultural Superintendent (Mr. F. H. S. Warneford), and by a Specialist Research Officer (Mr. C. F. Charter) employed by one of the large Sugar Companies, acting with the advice and guidance of the Adviser in Sugar-Cane Experiments to the Commissioner of Agriculture (Mr. P. E. Turner). Recently, additional chemical and

physical investigations into the peculiar features of the Antiguan soils have been undertaken by the writer, in continuation of the earlier studies described in Part V of the series under consideration. This additional work may be described in a further publication on the Soils of Antigua, to be issued later in the present year (1936), or early in 1937.

(6) The sixth article of the series is entitled "*Some Soil-Types of Jamaica*". It comprises an account of the origin, formation, classification and agricultural relationships of the main kinds of soil that occur in this large island of the Greater Antilles. It is the outcome of a joint investigation, undertaken in September 1932, by the Agricultural Chemist of the Jamaica Department of Agriculture (Mr. H. H. Croucher) and the Chemistry Department of the Imperial College of Tropical Agriculture. This publication was issued in August, 1933. The soil-types investigated are mainly devoted to the growth of bananas and sugar-cane. The field and laboratory data enabled tentative comparisons to be drawn between the soil-types of Jamaica and certain types belonging to well-known world-groups, such as have been defined by Russian and American pedologists. Furthermore, they provided valuable information concerning the climatic and soil requirements of two important tropical crop plants —banana and sugar-cane—which has since been employed in attempts to assess and evaluate other soils planted to these crops in other parts of the West Indies region, notably British Honduras and Trinidad.

The agricultural soils of Jamaica may clearly be classified into soils derived from calcareous parent rocks (such as the white limestones that comprise the great interior plateau occupying over four-fifths of the island), and soils derived from non-calcareous rocks (such as the old alluvial deposits that occupy the vast southern coastal plains around Kingston and in the parishes of St. Catharine and Clarendon). Within the regions occupied by these two geological subdivisions, the agricultural lands may be further classified into wet lands and dry lands, according to the magnitude of the annual rainfall. Finally, within the wet and the dry districts, the lands may be differentiated into flat lands and hilly lands. The interplay of the three factors, nature of parent rock, rainfall, and topography, has resulted in the development of several distinctive soil-types, showing natural gradations or intermediate stages, and ranging between very wide extremes. Saline and alkaline dry-land soils, similar to some of those occurring in Antigua described in the last section, represent one extreme, and deep red earths, derived from upland limestones or from ancient basement conglomerates under conditions of high rainfall, represent the other extreme. The multiplicity of environments thus displayed in Jamaica favours great diversification in agricultural cropping, and offers numerous interesting problems, both in pedology and in crop ecology.

(7) The seventh article of Studies in West Indian Soils, namely, "*The Cacao Soils of the Montserrat District of Trinidad*" (published in October 1933) reverts to a fuller discussion of the inter-relationships between climatic and soil conditions and the growth and reproductivity of the cacao tree. The fact that cacao was planted in Trinidad under a wide range of conditions when prices were high, has furnished valuable material, both for ecological and economic study. Since prices have dropped, greater interest has been shown in the costs of production of cacao, and the quantitative data recently collected have revealed the great importance of the nutrient status of the soil which differs widely for the different soil-types. The main aim of the soil investigation described in publication No. VII, was therefore to establish as closely as possible the relative importance of the soil factors responsible for high yielding capacity, and contrarily, for low yielding capacity for cacao. The distribution of "good" and of "bad" cacao soils, and the full description of soil-types falling within these two broad categories, were attempted for some 80 square miles of irregular country comprising the Montserrat District. A detailed soil map of the area was prepared by Mr. J. A. McDonald, and numerous soil samples, representing some 85 different soil profiles, were fully analysed in the laboratory. The results of this detailed investigation amply substantiated those obtained from the earlier study of the *Cacao Soils of Tobago* (Publication No. III), and more clearly identified the main soil factors associated with high cacao yields. In particular, they further stressed the importance of the nature and amount of the organic matter component of the surface soil, and the total and relative quantities of available phosphate and potash in the soil. An important outcome of the work was the inauguration of a series of specific manurial experiments on cacao as part of the College Cacao Research programme. These field experiments have since been greatly extended by Dr. F. J. Pound, Agronomist of the Trinidad Department of Agriculture, in connection with the new Cacao Relief Scheme, which was launched in 1935. The further exploration of the cacao soils of Trinidad into districts where other well-defined types of soil occur is being actively pursued. Descriptive accounts of the progress made and of any new results which may accrue from these continued investigations will form the topics of future articles of the series.

The cacao soils of Trinidad differ from those of Tobago and Grenada in that they have been derived mainly from sedimentary rocks. Only one very small area of outcropping igneous rock occurs in Trinidad (near Toco on the north-east coast), but its derived soils have not yet been studied in detail. Certain of the sediments contain the mineral gypsum; soils formed from gypseous rocks appear to be very unsuitable for cacao production. Thus, the cacao soils of Trinidad offer a wide range of problems, and it is hoped that their exhaustive study may provide

important generalisations which will be of value to cacao growers, not only in the West Indies, but also in other parts of the Tropics.

(8) The next article of Studies in West Indian Soils (No. VIII), published in December 1934, concerned an entirely different set of problems, associated with another kind of tropical crop, whose requirements are very different from those of the crops that had previously been examined. It is entitled "*The Agricultural Soils of St. Vincent*", and it discusses the soil relationships of the arrowroot plant. This article was published in December 1934, with the collaboration of an ex-student of the College, Mr. C. K. Robinson, now Assistant Superintendent of Agriculture in St. Vincent.

The parent soil-forming rocks of St. Vincent are mostly volcanic agglomerates, loose ash and dust. In this respect they differ from those of the neighbouring island, Grenada, which are mainly compact igneous lavas. Some of the St. Vincent volcanic ash was spread over the northern part of the island during the last eruption of the Soufrière Mountain in 1902 and 1903. Heavy rains have since removed the greater part of the ash accumulations, but at least one-third of the total area of the land still consists of recent volcanic ash, which has not yet been very much altered by weathering agents. The rest of the land area is made up of much older fragmental volcanic rocks, which have been considerably altered and weathered, and often cemented into hard gritty material known locally as "terras". Few lava flows occur in St. Vincent. The kinds of igneous rock comprising both the lavas and the fragmental materials are similar to those occurring in Grenada, namely andesites and basalts, but chemical analysis has revealed the striking fact that the St. Vincent rocks contain significantly lesser amounts of total potash.

The soils of St. Vincent thus differ very materially from those of Grenada described in article No. IV of the Studies in West Indian Soils. Whereas many of the Grenada soils are red or red-brown clays and loams, the soils of St. Vincent are mostly ochre-yellow, brown or black sands, containing little mineral colloidal matter. Evidently rock weathering has proceeded much farther in Grenada than in St. Vincent, a fact which is clearly demonstrated by a microscopical examination of profile samples representative of the different types of soil occurring in the islands.

The study of the volcanic ash soils of St. Vincent furnished an excellent opportunity for applying the methods of *mineralogical analysis* recently advocated by Dr. Vageler in his book "Tropical Soils" (1933), who claims that "the permanence of fertility in a soil varies with its content of minerals which are still liable to decomposition". The mineral analyses were performed by a Post Graduate student of the College (Mr. R. A. Hamilton), who found that the St. Vincent soils consist almost entirely of unaltered fresh mineral grains (soda-lime felspars, hypersthene, augite, magnetite and olivine). On the other hand, the red soils of Grenada contain less than 25 per cent. of unaltered mineral grains, and generally not more than seven per cent., though certain of the sandier ash and tuff soils may contain up to 34 per cent. of fresh grains. Only in very few cases, however would the soils of Grenada be considered to be definitely deficient in fresh minerals, according to the standards suggested by Vageler, but some of them might be regarded as border-line cases, whose degree of permanence of fertility may be low.

The fundamental differences between the soils of St. Vincent and those of Grenada are clearly reflected in the kinds of crops grown, and the types of agriculture practised in the two islands. Whereas cacao is the main crop of Grenada, arrowroot and cotton are the crops chiefly cultivated in St. Vincent. These two crops require a drier habitat than cacao, and well-drained, highly permeable sandy soils, such as abound in St. Vincent, are eminently suited to their moisture requirements, and their methods of planting and reaping, even in districts where the rainfall is high. Chemical analysis has revealed the fact, however, that the St. Vincent soils are not altogether satisfactory with regards to their nutrient status, and critical field manurial experiments have demonstrated that nitrogen and potash are the chief nutrients that are generally deficient, both in arrowroot and in cotton fields; where potash is abundant, additional nitrogen can be utilised with benefit to the crop. A useful rough index of soil suitability is furnished by the potash/nitrogen ratio of the soil. The production of abnormal arrowroot rhizomes ("cigar roots") also appears to be associated in some manner with unsatisfactory nitrogen and potash supplies in the soil, not only with regard to the total amounts of these nutrients, but also with regards to their ratio-balance or *proportionate* amounts.

Organic matter has long been suspected of exercising a particularly important rôle in the fertility and productivity of the soils of the cotton and arrowroot lands of St. Vincent; organic mulches have frequently given very large increases in crop yields. A critical study of this question, based on laboratory data and field experimental results, has indicated that the main effect of organic manure is nutritional, due to its high content of nitrogen, although a possible solubilising effect on the soil minerals of carbonic acid, produced by its oxidation in the soil, may increase the availability of their potash and phosphate contents.

(9) The ninth article of the series describes "*Some Soil-Types of British Honduras, Central America*", and was published in December 1935. It was the outcome of an arrangement between the Government of British Honduras and the Principal of the College, whereby a reconnaissance

survey of the chief soils of the Colony should be made with a view to deciding their suitability for the continuation and possible extension of banana, grapefruit and sugar-cane cultivations. The investigation afforded an opportunity of testing some of the conclusions reached in former studies with regards to the ecological requirements of these three important tropical crops. The field work was undertaken with the co-operation of Mr. H. P. Smart, Agricultural Officer of British Honduras, and of Messrs. J. B. Kinloch and R. S. Pelly, Forestry Officers. The lands of British Honduras are mainly undeveloped.

Less than seven per cent. of the total area of British Honduras is occupied by existing or recently-abandoned cultivations, whilst more than 50 per cent. is covered by tropical rain forests which occupy most of the interior lands. The rest of the area (43 per cent.) comprises swamp forests of the coastal and riverain strips, wet and dry savannahs, and intermediate lands. The chief agricultural soils occur on river alluvial lands, such as those within the Stann Creek Valley which were once famous for commercial banana production until Panama Disease devastated the cultivations. The Stann Creek area has been recently reopened for peasants' settlement, and several flourishing grapefruit plantations have replaced many of the former banana fields. The soils are variable and generally highly acidic, but their nitrogen and potash contents are high, though their phosphate content is low. The laboratory data obtained for these soils have suggested lines for field experimentation with a view to formulating suitable manurial treatments. Comparisons with data for other banana and grapefruit soils occurring elsewhere in the West Indies region have proved very useful in assessing the nutrient status of the Stann Creek alluvial soils.

The greater part of British Honduras is covered with black and red soils derived from soft marls and hard Tertiary limestones. These calcareous deposits form flat plain country of low relief, extending far northwards into Yucatan. Most of the land is closely afforested and abounds with relics of the ancient Maya civilisation, such as terraces and mounds. Around Corozal, in the extreme north of the Colony, occurs a deep, rich, black marly soil which grows magnificent sugar-cane crops, but a sugar industry has not yet been developed and centralised there, though plans are now being advanced for the erection of a large sugar factory, which should greatly encourage the development of the Corozal district. Other parts of the marl and limestone region, within access by road of Belize (for example, the Boston District) may soon be planted in bananas. The soil is neutral or alkaline and quite fertile, but it is frequently underlain at shallow depths by flints or hard limestone which seriously restrict the root room.

The southern part of British Honduras experiences very high annual rainfall (over 100 inches). Certain of the alluvial soils bordering the more navigable rivers are partly developed for agriculture, but the greatest expanse of productive land occurs around Punta Gorda (Toledo District), which was originally settled by Americans after the Civil War in the United States. The soil is derived from Miocene sediments of variable composition, including some that are highly calcareous. Many of the soils are quite fertile, though somewhat lacking in potash. They support fair crops of sugar-cane, but they would require special treatment to enable them to produce profitable bananas. Hill rice is being grown in certain parts of the district, and a rice experimental station has recently been established near Punta Gorda.

The forests of British Honduras have been classified into different associations dominated by distinctive tree species, certain of which, such as mahogany, have considerable commercial value. The chief factors which appear to have affected the distribution of the forest types are rainfall, topography, kind of soil, and interference by man. The chief controlling agency is probably soil water supply, whose magnitude depends on the interaction of these factors, and particularly on the physical properties of the soil, which differ significantly between porous sands, impervious acidic clays and permeable calcareous clays or marls, all of which are represented among the soils of British Honduras.

It is evident from this summary of some of the main findings of these studies that a very wide range of problems is presented to the scientific investigator of the soils of the West Indies region. The climate varies widely in different parts of the region and within each insular area or country. The soil-forming rocks include almost every main type known to the geologist. Every stage of agricultural development is represented, ranging from forest exploitation, shifting cultivation and peasant settlement to estate organisation, orchard management and intensive gardening. Numerous different kinds of tropical and sub-tropical crops are grown, both herbaceous and arboreal, and many different systems of cultivation are practised, involving hand tillage, implemental tillage, thorough drainage, irrigation, cover cropping and all sorts of manuring. The value of exact field experimentation is gradually being realised, and the need of detailed soil surveys is becoming increasingly experienced as economic conditions and external competition is forcing the agriculturist to learn how to conserve soil fertility, to improve yields, and to diminish costs of production. Since the soil is the basis of all agriculture, the continued investigation of these problems will always demand first attention. The accumulation of such relevant data as can be obtained by reliable methods of field and laboratory research thus requires no justification, and the start that has already been made in the study of West Indian soils should lead the way to their fuller understanding.

# WEST INDIAN NOTES.

*(Compiled by the Advisory Department, Imperial College of Tropical Agriculture.)*

## The Sugar Industry.

The total production of sugar in the British West Indies in 1936 was larger than that of 1935 and larger than the crop estimates given in these columns in April. New record productions were made in Trinidad and Barbados as the result of a slightly extended area under cultivation and a greater yield per acre. In Antigua favourable weather conditions in the latter part of the crop season caused the final crop figure to be considerably greater than the estimate at the beginning of crop. Total production figures for the 1936 crop are given in the following table :—

| *Island.* | *Tons of Sugar.* |
|---|---|
| St. Vincent .... .... | 1,550* |
| St. Lucia .... .... | 8,200* |
| Antigua .... .... | 21,386† |
| St. Kitts .... .... | 28,174 |
| Barbados .... .... | 129,150‡ |
| Trinidad .... .... | 154,665 |

* Estimate.
† Including 500 tons muscovado sugar.
‡ Including fancy molasses equated to sugar.

Further useful results were obtained during the past crop season from the experimental programmes laid down by the respective Sugar Cane Investigation Committees in Antigua and St. Kitts under the direction of Mr. P. E. Turner, Sugar Cane Agronomist. A summary of the results will be published in this Journal. The information already acquired has proved to be of great assistance in laying down further experiments designed to solve the many cultural and manurial problems awaiting solution.

* * *

## The Cotton Industry.

Total production figures for those Islands which have already completed their crop in the present year and estimates of production in certain others are given in the following table :—

| Island. | Year. | Production —lb. lint. |
|---|---|---|
| Virgin Islands .. | 1935-36 | 8,000* |
| Barbados .. .. | ,, | 9,594 |
| Anguilla .. .. | ,, | 30,471 |
| Antigua .. .. | ,, | 105,000* |
| Nevis .. .. | ,, | 211,819 |
| St. Vincent .. .. | ,, | 394,000 |
| St. Kitts .. .. | 1936 | 200,000* |
| Montserrat .. .. | ,, | 700,000* |

*Estimate.

The very dry weather conditions experienced in Montserrat in the first half of the year (referred to in these columns in July) have reacted unfavourably on crop production. Early dry conditions were followed in July and August by too much rain, resulting in much boll disease and a heavy infestation of pink bollworm. The crop is estimated at about 700,000 lb. of lint or less than three quarters of last year's crop.

The cultivation of cotton has been started afresh on a small scale in St. Lucia with seed supplied by the Agricultural Department, Montserrat.

As the outcome of a request made by the West Indian Sea Island Cotton Association at its annual general meeting in St. Vincent in January, 1936 for the establishment of an entomological service. Mr. F. A. Squire, until recently Entomologist in British Guiana, has been appointed as Entomologist for cotton pest investigation in the Windward and Leeward Islands. The appointment has been effected by means of financial assistance in the form of a free grant from Colonial Development Funds. For the purpose of discipline and administration Mr. Squire will be subject to the control of the Commissioner of Agriculture.

Following upon the recommendation of the West Indian Sea Island Cotton Association, that in all the cotton growing Islands a system of supplying cotton seed for planting purposes through a single channel, namely the Agricultural Department, should be adopted, legislation has been introduced into Montserrat and Nevis constituting the local Agricultural Departments as the sole suppliers of cotton seed for planting purposes.

* * *

## The Citrus Weevil Investigation.

Mr. R. G. Fennah, Lecturer in Entomology, has continued the investigation of the citrus weevil problems in St. Lucia reported in the July issue of this Journal, and extended the investigation to Montserrat. He made visits both to St. Lucia and Montserrat in July.

The general situation in respect of the weevil in St. Lucia in July is indicated by the following extract from Mr. Fennah's report.

"*The General Situation in July.*

Owing to the amount of time spent in the collection of data from the experiments, it was not found possible to make a tour of inspection of the citrus estates. From observation of trees at Union Estate, the condition of which had been noted by the writer in April, and from information supplied by officers of the Department of Agriculture, it appears that the arrival of the wet season has generally induced recovery growth on the part of trees damaged by weevil attack. At Union a programme of irrigation was started in April but within a very short time it became unnecessary to proceed further with this on account of the oncoming of frequent rain. At

other estates a similar resuscitation of vegetative activity has been noted in the case of both budded and seedling material.

A certain amount of leaf chlorosis was noticeable at Union though by no means as severe as it had been two months previously. Elsewhere there were indications that chlorosis had developed after a flush of new growth on account of temporary waterlogging of the soil following a period of heavy rain.

There was no report of damage having been caused by the adults nibbling young fruit, and the writer observed only one small lime fruit so damaged during his excursions. Leaf-damage was seen, though never approaching in severity that noted in Montserrat."

Two additional methods suggested by Mr. Fennah for controlling the weevil, which are being given trial in St. Lucia, are described below in detail. Mr. Fennah considers that these treatments are worthy of a trial application on a commercial scale pending the results of the carefully planned and controlled experiments.

The two methods as described in Mr. Fennah's report are as follows :—

"Treatment (I). The application of acid lead arsenate to the soil. 10 lb. of acid lead arsenate are mixed with 85 lb. of sand or sifted top soil and five pounds of air-slaked lime are added during mixing. The work must be sufficiently thorough for the whole heap to be of an even colour. A circle of four feet radius is described round the trunk of each tree, and the weeds in this area of 50 square feet are closely cutlassed and raked aside so that the soil surface is exposed. 2½lb. of the lead arsenate-lime-soil mixture is evenly sprinkled over this area. This may perhaps most easily be done by treating one quadrant of the circle at a time, the labourer being given a measure with a mark on it to indicate 10 ounces, and told to apply just that amount evenly to each quarter circle. As application is made in the rainy season the poison will be carried down into the soil whenever a heavy shower occurs. The amount given above for mixing is sufficient for forty trees, and it is of convenient size for weighing and shovelling.

The cost per tree of this treatment, including lead arsenate, lime, mixing, cleaning beneath the trees and applying should not exceed 3 1-5*d*. Treatment will have to be repeated annually for three years, after which it may be feasible to omit every alternate year, owing to the residues from previous treatments being sufficient to render the soil grub-proof.

The lead arsenate is not likely to have any deleterious effect on the lime tree. It has been determined (*Journ. Chem. Soc.*, Feb., 1914) that it actually stimulates ammonification in the soil and is toxic to plants only when large amounts are present. When used in Trinidad on the roots of grass no permanent injury was caused.

Treatment (II). The application of carbon bisulphide emulsion. If this is carried out, it will be necessary to repeat the application annually. It is a fumigant treatment, and is quite independent of Treatment (I). It is not connected directly with the feeding habits of the larvae, but with their distribution in the soil.

The formula being employed in the experiments is as follows :—

| | |
|---|---|
| Carbon bisulphide .... .... | 7 lb. |
| Cotton-seed, Soy bean, or Castor oil .... .... .... | 3 lb. |
| Fish-oil soap .... .... | 6 ounces. |
| Washing soda .... .... | 1½ ounces. |
| Water .... .... .... | 1 gallon. |

*Preparation* : 1. The carbon bisulphide is poured into the oil and they are mixed by gentle stirring. *This is highly inflammable.*

2. The water is heated in an oil drum or tin over a fire, and the soap and soda dissolved in it. The vessel is then removed completely from the fire and the carbon bisulphide-oil mixture is gradually poured in, the liquid being agitated all the time, either by vigorous stirring or by a pump, until a creamy emulsion is obtained. One part by volume of this emulsion is diluted with two hundred parts of water. The resulting emulsion is applied at the rate of three gallons per tree, poured into holes six inches deep made at intervals beneath the canopy, or into a shallow trench, about four inches wide and two or three deep, with the soil at the bottom loosened, made about two feet away from the trunk in a circle round the tree. Excluding application, the cost should not exceed 1 3-5*d*., at 3½ gallons per tree, 1 4-5*d*., and at 4 gallons, 2*d*. Applying will probably cost a further 2*d*. per tree.

Of the two treatments (I) is to be preferred, as its effects on the soil are more lasting, and it appears rather more reliable in its insecticidal effects.

Application in St. Lucia may be made at any time after oviposition has occurred (mid-July) until about October, but preferably should not be delayed after July longer than necessary, as the minimum lethal dose of poison varies directly with the size of the larva. Application after October is unlikely to have any effect on the larval population of the same year, and in the case of carbon bisulphide would probably have no appreciable effect at all.

Experiments, now in the charge of the Department of Agriculture, have been set up to test the effects of these treatments, but as it is already time to apply them, it is considered that in view of their low cost it is preferable to offer them as suggestions now, to be adopted or not as the planter thinks fit, rather than to allow months to pass, and then perhaps to announce them as definite recommendations."

### Banana Exports.

In the following table the quantity of bananas supplied by the various Island organisations to the Canadian Banana Co. for the first eight months of 1935 and 1936 are set forth :—

**Bananas Exported to the Canadian Banana Company for the period January-August, 1935 and 1936.**

| | Trinidad. | | Grenada. | | St. Vincent.* | | St. Lucia. | | Dominica. | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1935. | 1936. | 1935. | 1936. | 1935. | 1936. | 1935. | 1936. | 1935. | 1936. | 1935. | 1936. |
| Nines .. .. | 12,044 | 36,697 | 6,675 | 34,998 | 76 | 3,644 | 8,649 | 17,567 | 9,028 | 16,511 | 36,472 | 109,417 |
| Eights .. | 11,352 | 34,056 | 5,985 | 28,812 | 80 | 6,032 | 9,180 | 19,424 | 10,520 | 17,844 | 37,118 | 106,168 |
| Sevens .. | 13,318 | 36,408 | 6,477 | 30,852 | 100 | 8,644 | 9,394 | 22,052 | 12,058 | 20,398 | 41,345 | 118,354 |
| Sixes .. .. | 20 | 376 | 2,475 | 7,832 | 4 | 1,888 | 1,580 | 3,896 | 1,372 | 1,296 | 5,452 | 15,288 |
| Total Stems .. | 36,734 | 107,537 | 21,612 | 102,494 | 260 | 20,208 | 28,803 | 62,939 | 32,978 | 56,049 | 120,387 | 349,227 |
| Equivalent Counts .. | 27,222 | 80,537 | 15,021 | 73,991 | 187 | 12,962 | 20,626 | 44,244 | 23,290 | 40,412 | 86,346 | 252,146 |
| Percentage Counts .. | 74% | 75% | 69% | 72% | 71% | 64% | 71% | 70% | 70% | 72% | 71% | 72% |

* 1st Shipment July, 1935.

### Vegetables in Montserrat.

Montserrat is the chief exporter of vegetables to the Canadian market. During the tomato season, which normally extends from January to June, 46,000 crates of tomatoes valued at £7,000 were exported to Canada. Climatic conditions were unfavourable in the latter half of the season this year ; very dry weather causing a cessation of exports from about the middle of May.

During the first eight months of the year the exports of carrots to Canada and the West Indies was 1,400 crates, only half the quantity for the corresponding period of last year. But exports of onions were more than double at 1,144 crates.

* * *

### St. Vincent Arrowroot.

The arrowroot crop in St. Vincent for the year 1935-36 amounted to approximately 35,000 barrels (220 lb.) representing a further small increase over the crop of the previous year. Exports have been well maintained. The young crop made good progress up to the end of July, but suffered severe damage from an attack of arrowroot leaf-roller during August. The majority of arrowroot planters are now applying sulphate of ammonia with apparently beneficial results.

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### Brevities.

Mr. S. H. Evelyn, Cotton Research Officer, St. Vincent, visited Montserrat from 29th June to 11th July to investigate and report upon the technique employed for the production of pedigree cotton seed and upon other matters relating to the cotton industry.

Mr. C. C. Skeete, Assistant Commissioner of Agriculture, visited Antigua, Montserrat, St. Kitts and Nevis in July.

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Mr. P. E. Turner, Sugar Cane Agronomist, visited Antigua and St. Kitts in July in connexion with the sugar-cane experimental programme.

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Mr. H. E. Box, Entomologist, left St. Lucia on 25th June on three months leave prior to the termination of his appointment under Colonial Development Fund Scheme No. 282.

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Mr. R. G. Fennah, Lecturer in Entomology, visited Montserrat from 29th June to 11th July and St. Lucia from 12th to 26th July in connexion with the citrus weevil control investigation.

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Dr. A. Skovsted of the Cotton Research Station, Trinidad, visited St. Vincent from 5th to 11th August to advise the Cotton Research Officer on the programme of genetics work for the ensuing year.

* * *

Mr. F. A. Squire, Entomologist for Cotton Pest Investigation in the Windward and Leeward Islands, arrived in Trinidad on 6th September and assumed the duties of his appointment. Mr. Squire is attached to the Agricultural Advisory Department of the College for the purpose of discipline and administration.

## REVIEWS.

### RECENT IMPROVEMENTS IN THE SIMPLE CLARIFICATION FOR RAW SUGAR PRODUCTION.

By J. G. Davies, *Imperial College of Tropical Agriculture*, Trinidad, B.W.I., 1936. 31 figs. 38 pages, 2*s*.

In this review, the author has attempted to bring up to date the collected literature on raw sugar clarification. The period covered is from 1920 to 1935 and 176 references and patents have been read and incorporated therein. In the introduction, it is stated that "No personal opinions have been expressed . . . but instead, author's opinions have been accepted and set out one beside the other . . ." The work is divided into eight sections. The first deals with the components of cane juice. The second discusses the effects of lime, phosphoric acid and heat on these components and is suitably sub-divided. The third section takes into account (*a*) liming, and (*b*) phosphating in all their factory aspects. The fourth is entitled "Juice heating and juice heaters" and the fifth "Intermittent and continuous clarifiers". This latter section describes twenty-one different continuous clarifiers. The sixth section is about clarification processes and the seventh and eighth are Acknowledgments and Bibliography respectively. The review was written essentially for Sugar Technology students, but it is of interest to the factory man because, by reading it, he is able to obtain a comprehensive survey of all that has been done in clarification in the last fifteen years, together with a reference to the original paper from which the information was obtained.

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### THE SCIENTIFIC PRINCIPLES OF PLANT PROTECTION WITH SPECIAL REFERENCE TO CHEMICAL CONTROL.

By Hubert Martin, D.Sc. (Lond.), A.R.C.S., F.I.C., *Edward Arnold & Co.*, London. Second Edition, 1936. pp. 379, 21*s*.

Although the first edition of this book was only published eight years ago, research on plant protection and especially on spraying, has advanced so rapidly that a second edition has already become necessary.

The second edition is more attractive than the first, being printed on better paper in slightly larger type, and is 63 pages longer. While adhering to the plan of the first edition the author has largely rewritten the book with the exception of the introduction, and all sections have been brought up to date. A bibliography of the more important papers quoted in the text is given at the end of each section, while there is an Author Index at the end of the book. Chapter III, on "The influence of external factors on the susceptibility and liability of the plant to attack" has been extended to include the interesting subject of the meteorological forecasting of epidemics and also the problem of the control of temperature and humidity relationships. Among other subjects of special interest in the second edition are the recent advances in our knowledge of the use of spreaders and stickers, colloid sprays, the mercury group of seed disinfectants and chlorates as weed killers.

Of recent years many proprietary spray mixtures, dusts, disinfectants, spreaders and stickers with somewhat obscure though undoubtedly attractive trade names such as Adhesol, Penetrol, Agral, Bouisol, Kurkakol, Nosperal, Uspulun, Tillantin and so on have been put on the market. This book serves an admirable function in discussing the composition and possible uses of such preparations.

R.E.D.B.

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### SURVEYING

By A. H. Haines, *Longmans, Green & Co.*, London, 1929. pp. 210, price 12*s*. 6*d*.

This handbook is intended for the use of agricultural students, land agents and farmers. Its author is head of the estate management department, and lecturer in surveying at the South-Eastern Agricultural College, Wye, England. The outlook is essentially practical, and numerous diagrams and pictures of instruments provide good guides to the actual methods of land surveying and levelling. The field uses of the chain, the prismatic compass, the sextant, the plane-table and the theodolite are fully described. Information is also given in the methods of map and plan drawing, in the procedure for reducing maps from one scale to another by the employment of the pantograph, and in the measurement of areas enclosed by map boundaries by the use of the planimeter. All the main methods required by the surveyor appear to be adequately described, and the discussion of typical examples, showing how the field data are utilised in the construction of maps and plans, furnishes all the necessary details required for different purposes. The book can be highly recommended to students and practical agriculturists.

F. H.

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### THE FOURTH EDITION OF "RUBBER LATEX"

By H. P. Stevens and W. H. Stevens, issued by the Rubber Growers' Association, 19, Fenchurch Street, London, E.C.3., has recently appeared. It is largely similar to the preceding edition, but includes minor alterations and additions.

There are 190 pages of text, containing chapters on the following aspects of the subject: Source and Production, Properties, Composition, Stabilisation and Coagulation, Concentration, Manipulation and Compounding, Stabilisation for industrial purposes, Vulcanisation, Manufacturing by dipping and electrodeposition, Applications and products, and Marketing, with a final chapter —expanded in this edition—dealing with Patents Abstracts. Four pages of bibliography, in part with comment, are given at the end.

## SUGAR NOTES.

*Compiled by the College Department of Sugar Technology.*

**Sucrose Precipitation from Final Beet Molasses by Barium Hydroxide ;** *V. E. Malinovski and V. P. Novikova.*

From a survey of the literature and from their own experiments the authors conclude that it is possible to recover from a pure solution of sucrose 99.2 per cent. of the sucrose contained in the solution. The conditions necessary to this result are: a sucrose concentration of 30 per cent., a ratio of 1.4 molecules of barium hydroxide to one molecule of sucrose, a temperature of 75°C., and a time of action of 5 minutes. The optimum conditions of precipitating sucrose from final molasses are exactly the same as from pure sugar solutions, but the precipitation is not as complete. The precipitation is interfered with by the non-sugars of the molasses, and the extent of this interference varies with the character of the non-sugars and the conditions under which the beets have been grown. In certain districts, where the factories are characterized as " medium molasses factories " because they produce the average percentage of molasses, 92.32 per cent. of the sucrose in the molasses can be recovered by the barium hydrate process, whereas in a " high molasses factory ", as Ribinsko, the recovery is only 89.83 per cent. It is true that certain other Russian investigators have claimed recoveries of 98 and 97 per cent., but the present authors have been unable to confirm these results. They conclude that a recovery of 85 to 90 per cent. may be expected in normal factory operation, and in view of the fact that Russia has large deposits of barium sulphate (heavy spar) containing 96 per cent. $BaSO_4$, the introduction of this process should be feasible.—(*Facts About Sugar*, Vol. 31, No. 7, p. 266, 1936.)

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**Manurial Trials with Sugar Cane** ; *by S. J. Saint.*

This paper gives numerous details of fertilizer trials on the black and the red soils of Barbados with different quantities of nitrogen and potash. In the trials on black soils with plant cane, dry weather limited the crop to 14 tons per acre, so that fertilizers showed no effect, except that sulphate of ammonia may actually depress yields under dry weather conditions. At the red soil centre, the rainfall was a little more abundant ; here sulphate of ammonia had no effect on yield, but when used in large amounts, it had a depressing effect on sucrose percentage. On the other hand, potash increased both the yield of cane and the sugar content

In a second similar experiment on black soil in a medium rainfall district, nitrogen had a marked effect in increasing the yield of cane, although the yield diminished with each additional application of nitrogen. Potash had no significant effect.

In a three-year experiment with ratoons, it was observed that during the first two growing seasons there was no response to potash, and but little to nitrogen ; in the third year, plots receiving no fertilizer showed a decrease of yield, whereas those receiving fertilizer held up better.

Another section of the report gives results of trials where nitrogen was applied at different times (May, July, September). In one case, the time of application of sulphate of ammonia had no significance, whereas in another case, late applications were attended by a drop in yield. Addition of phosphoric acid to plant and ratoon crops had no significant effect on either yield or sucrose percentage.—(*Facts about Sugar*, Vol. XXXI, No. 8, p. 309, 1936.)

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**Crystal Surface Contaminants and Biological Quality of Sugar** ; *by H. H. Hall and L. H. James.*

It has been shown that when some sugars were made up in 10 per cent. solution with distilled water, sterilized, and subsequently inoculated with a known number of yeast cells and incubated for 72 hours at 30°C. various increases in the yields of yeast were obtained. This is taken to indicate the presence in the sugars of various quantities of substances that support yeast growth ; the variations found were quite wide, indicating relatively marked differences in the purities of the sugars, it was found that these impurities are mostly on the surfaces of the sugar crystals, as was proved by washing the sugars with sterile syrup and repeating the yeast growing experiment. It was found also that this washing removed most of the bacteria that are responsible for " flat sours " when contaminated sugar is used for canning purposes.—(*Facts about Sugar*, Vol. XXXI, No. 8. pp. 305-6, 1936.)

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**Washing Filter Cloths** ; *by W. Regner.*

When filter press cloths are washed and returned to use, the improvement in the filtration will depend on the thoroughness of the washing. From experiments made by the author, it appears that the most effective method of washing is to use, first, a 2 per cent. solution of sodium carbonate ; this dissolves out soluble silica. Then the crust of calcium carbonate is dissolved by heating for ten minutes in a 1½ to 2 per cent. solution of formic acid at 70°C. A dilute hydrochloric acid wash would be cheaper, but this acid weakens the fibres more than does formic acid. Cotton cloths stand the washing better than linen cloths, and much better than jute cloths, which appear to be more susceptible to the action of soda.—(*Facts about Sugar*, Vol. XXXI, No. 8, p. 308, 1936.)

## CHEMICAL NOTES.

*Compiled by the College Department of Chemistry and Soil Science.*

### Economics of Synthetic Rubber.

Within the past five years a synthetic rubber industry has arisen in Soviet Russia and in the United States; it is described by E. R. Bridgewater in *Indus. Eng. Chem.*, 28, p. 394, 1936. Synthetic rubber is also being produced on a small scale in Germany. Both the Soviet butadiene rubber, and the American chloroprene rubber are discussed, because the synthetic rubber industry is being developed in Russia and in America under economic conditions that are diametrically opposite to each other. Average cost of production of natural rubber is probably about five cents per pound. The latex has a variable composition, depending on the soil, age of trees, season of the year, and other factors. Rubber made in Russia from butadiene, produced by high-temperature cracking of ethyl alcohol, seems to be inferior to natural rubber. 20,000 tons was produced in 1935. Costs are not available, but the yield has been increased from 14.4 per cent. to 23 per cent.

Duprene is made by the polymerization of chloroprene, 2-chloro-1, 3-butadiene, which is made by the addition of hydrochloric acid to monovinylacetylene. The latter compound is made by the polymerization of acetylene in the presence of a catalyst consisting essentially of a saturated aqueous cuprous chloride and ammonium chloride. It might appear that Duprene is potentially capable of being produced as cheaply as natural rubber, but such is not the case. If the conversion of acetylene to monovinylacetylene, to chloroprene, and chloroprene to its plastic polymer, Duprene, could all be carried to completion without the formation of any by-product, 1.7 pounds of Duprene would be obtained from a pound of acetylene and 0.7 pound of hydrochloric acid. The process is interrupted before complete conversion in order to avoid the formation of a tough product. Duprene, compounded and vulcanized, is more resistant to abrasion, more resistant to oils, oxidation, high temperature, and diffusion of gases than products made from natural rubber.—(*Jour. of Chem. Educ.*, Vol. XIII, No. 7, p. 345, 1936.)

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### A New Nitrogenous Fertilizer.

Dr. M. M. McCool describes in a publication from the Boyce Thompson Institute in New York (Vol. VIII, p. 13, 1936) a new material manufactured by mixing untreated calcium cyanamide with the concentrated residue obtained from the alcoholic fermentation of molasses after the alcohol has been distilled off. The new manure compares favourably with tankage in its rates of ammonification and nitrification, and it should prove useful where a slow-acting nitrogenous manure is required.

### A New Safety Glass.

A new type of safety glass has been developed by the joint work of the Duplate Company and the Carbide and Chemicals Corporation of the United States of America. It is described by J. H. Sherts and E. L. Fix in *Chem. and Met. Eng.*, 43, p. 177, 1936.

In the older types of safety glass, cellulose nitrate is used as the interlayer. This developed a brown discolouration after a year or two of service, due to the actinic rays of the sun. This trouble has been overcome in part by substituting cellulose acetate, or by using a special filtering glass which has a higher iron content than ordinary glass. The addition of iron also imparts a cast to the glass which reduces road and general reflection glare. But even these glasses had certain drawbacks. In the latest safety glass, a new resin called "Vinylite X" and a plasticizer are used. The two ingredients are mixed and converted into sheets approximately 0.025 inch thick. These sheets are placed between clean plates of glass, and subjected to heat and pressure. This product shows no discolouration after 1000 hours' exposure to the Uviarc test. It will not decompose in 320 hours at 260°F., hence glazed automobiles can be passed through enamel-baking ovens without damaging the new safety glass—(*Jour. of Chem. Educ.*, Vol. XIII, No. 7, p. 345, 1936.)

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### Molasses and Nitrogen Fixation in Indian Soils.

Professor N. R. Dhar, of the University of Allahabad, writing on 29th April with reference to the article on "Molasses, Nitrogen Fixation and Land Reclamation" which appeared in *Nature* of 11th April, says: "I am glad to inform you molasses is being utilised in many parts of India for reclamation of alkaline land. The Mysore Government has been able to obtain 1,200-1,800 lb. of rice grains per acre of alkaline land using one ton of molasses per acre on plots where crops failed previously. The normal production of rice in India is 1,250 lb. of grain, per acre in ordinary fields. In recent publications we have shown that the ammoniacal and total nitrogen of ordinary soils mixed with cane sugar or glucose or any other energy-rich compound and exposed to sunlight increase considerably although the *Azotobacter* counts do not change appreciably. In the dark, however, the *Azotobacter* counts are enormously increased, although the ammoniacal and total nitrogen are less than in light. Moreover, we have obtained results showing the accelerating influence of light on ammonification, nitrification and dentrification under aerobic conditions. Hence we have come to the conclusion that sunlight plays an important rôle in the nitrogen cycle in the soil".—(*Nature*, Vol. CXXXVII, No. 3476, p. 1000, 1936.)

## TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observation is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Markets have ranged as follows (c.i.f. per cwt.) :—

| | *Foreign.* | | *Preferential.* | |
|---|---|---|---|---|
| | *s.* | *d.* | *s.* | *d.* |
| 30th July .... .... | 4 | 5½ | 8 | 2½ |
| 6th August .... | 4 | 6 | 8 | 3 |
| 13th August .... | 4 | 5½ | 8 | 2¼ |
| 20th August .... | 4 | 5¼ | 8 | 2¼ |
| 27th August .... | 4 | 6 | 8 | 3 |
| 3rd September .... | 4 | 6 | 8 | 3 |
| 10th September .... | 4 | 5¼ | 8 | 3 |
| (*12th September*, 1935) | 4 | 3 | 8 | 0 |

With a lack of activity on either side of the Market, and in the absence of any development of influence, prices have remained practically unchanged.

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COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association :—

| | *American Mid.* | *Egyptian F.G.F. Sakel.* |
|---|---|---|
| 31st July .... .... | 7.10 | 11.23 |
| 7th August .... .... | 7.02 | 11.20 |
| 14th August .... .... | 6.92 | 11.01 |
| 21st August .... .... | 6.74 | 10.34 |
| 28th August .... .... | 6.71 | — |
| 4th September .... | 6.81 | — |
| 11th September .... | 6.99 | — |
| (*13th September*, 1935) .... | 6.17 | 8.11 |

Trading conditions were notably affected by the American Government crop estimate, which, at 12,481,000 bales, was about 300,000 bales more than expected. Prices fell rather sharply in Liverpool, but some recovery was made later. It is recognised that the final output of cotton will depend upon weather conditions in the belt for the next two months. Prices for West Indian Sea Island have remained steady, and rather more business has been transacted.

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COFFEE.—With no fresh arrivals of importance coming to hand, the statistical position of the market should continue to improve and already compares favourably with recent years, with the exception of East India Coffees, of which there are still large stocks in importers hands.

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GRAPEFRUIT.—The imports into the United Kingdom for the fortnight ended 25th July amounted to 61,715 cwt. consigned by the following countries: South Africa, 23,582; Southern Rhodesia, 307; British Honduras, 398; Portuguese East Africa, 6,443; U.S.A., 24,750 Paraguay, 1,938; Brazil, 2,447; Argentine, 1,195; other countries, 655.—(*West India Committee Circular*, 13th August, 1936.)

RUBBER.—Quotations for plantation sheet have ranged as follows :—

| | *Pence per lb.* |
|---|---|
| 29th July .... .... .... | 7 3-4 |
| 5th August .... .... .... | 7 5-8 |
| 12th August .... .... .... | 7 9-16 |
| 19th August .... .... .... | 7 5-8 |
| 26th August .... .... .... | 7 5-8 |
| 2nd September .... .... | 7 11-16 |
| 9th September .... .... .... | 7 5-8 |
| (*11th September*, 1935) .... .... | 5 9-16 |

Stocks in the United Kingdom have declined still further, a total decrease of 45,613 tons having occurred during the uninterrupted downward movement of the last 24 weeks. Total consumption in the U.S.A. for the first seven months of the year is 331,095 tons compared with 292,198 tons for the same period last year. The July consumption was 48,127 tons or 1,851 per working day. The figure is considered slightly disappointing as 50,000 tons had been expected. The market has been inactive, and prices have moved very little.

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COCOA.—There was a good undertone to the cocoa market since last writing, and during the latter half of the month large quantities of spot cocoas were disposed of at full prices. It is reported that sales of Accra and Lagos of the new crop have been the largest on record at the prices asked, and with the Bahia crop pretty well disposed of the position of the market is very strong. New Crop Accra is being offered at 23*s.* c.i.f. and locally $11.00 per fanega is paid for Plantation Cocoa.—*By Courtesy of the Cocoa Planters' Association of Trinidad, Ltd.*)

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BANANAS.—The demand has been affected by the supplies of soft fruit and the price of Jamaicas has been lowered by £1 per ton to £19 5*s.* delivered London or £19 nearest station Provinces. Brazilians are unchanged at £15 and in fair request.

The imports into the United Kingdom for the fortnight ended 25th July amounted to 908,361 bunches consigned by the following countries: Gold Coast, 3,207; Jamaica, 505,176; Trinidad, 5,923; Cuba, 10,406; Canary Islands, 14,166; Guatemala, 52,717; Colombia, 71,471; Honduras, 151,997; Brazil, 93,298.—(*West India Committee Circular*, 13th August, 1936.)

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LIME PRODUCTS.—*Lime Oil.*—Handpressed is very slow of sale and valued at 32*s.* 6*d.* to 35*s.* There are sellers of Distilled at 22*s.* 6*d.* but no demand. *Lime Juice.* There is no inquiry for Concentrated. The season has been disappointing for Raw. The value is nominally unchanged at 2*s.* to 2*s.* 6*d.* according to quality.—(*West India Committee Circular*, 13th August, 1936.)